

Threatened Drosera

Pg 34



Black Tiger

Pg 20



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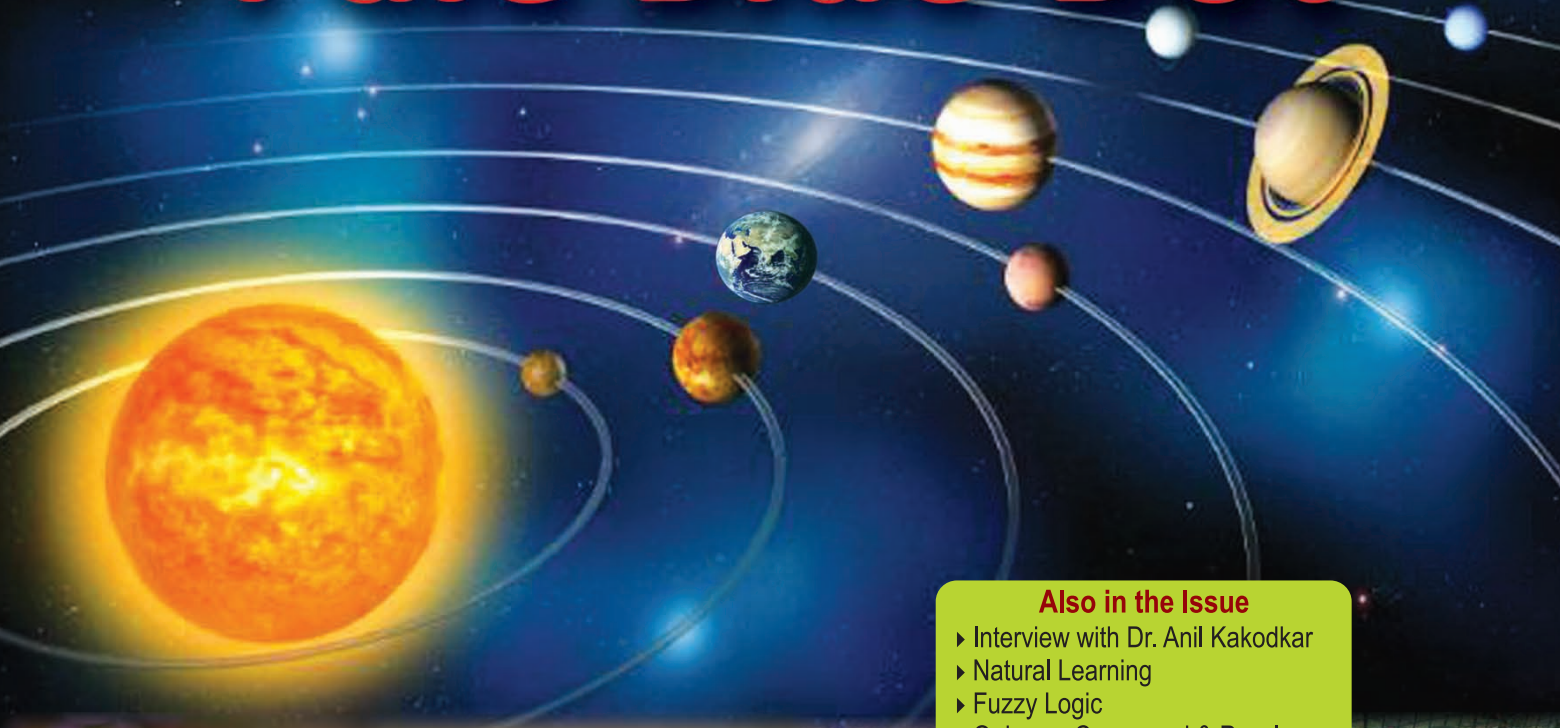
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The Earth is only a

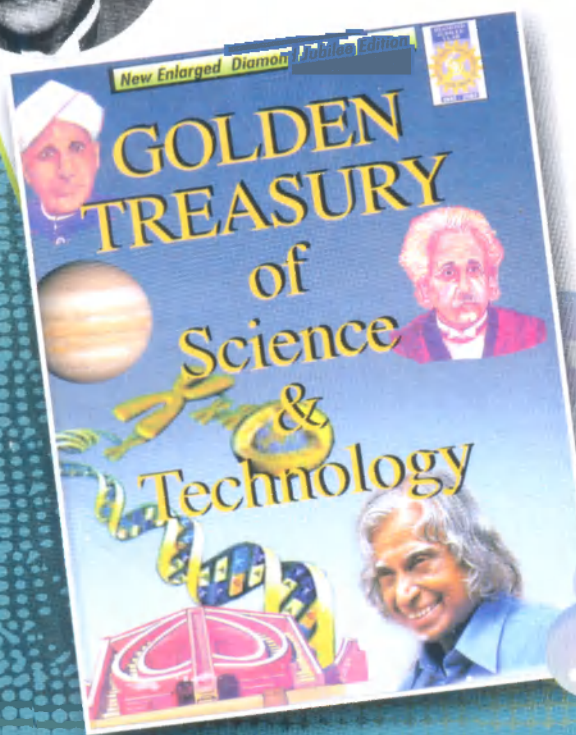
Pale Blue Dot



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Science Reporter, AUGUST 2016



COVER STORY

A Pale Blue Dot

FELIX BAST

Humans should not disregard other organisms co-inhabiting this planet, which is only a pale blue dot on the vast fabric of space. **Pg 14**



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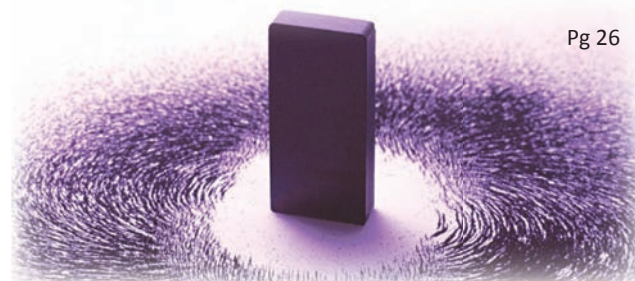
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Science Reporter



HARVEST WATER TO FIGHT DROUGHT

The June 2016 issue of *Science Reporter* was highly



informative. The issue dealt with some of the problems that the country is grappling with in today's times such as drought, climate refugees, sustainably managing waste and water harvesting. We need to learn from our traditional customs of water harvesting to fight problems like drought.

Deva Singh
Village Kodari, Gorakhpur

KEEP WATER CLEAN

The editorial, **Make Every Drop Count** in the 2016 June issue by Hasan Jawaid Khan was quite impressive, informative and inspiring. It talked about being careful about the way we use water.



Life originated in water. It is the most valuable natural resource we possess. The most threatening problem is pollution. Even when we shall have an abundance of water, pollution might contaminate our resources in stock, eventually threatening our future.

Tons of sewages and non-biodegradable wastes are entering the water bodies at a far greater rate than the rate at which nature can purify it and make it safe enough for us to use. It is already known, that very lethal chemicals like DDT have already entered the food chain and have reached up to the top trophic levels, the level where we humans stand.

To counteract this, we need scientific researches and breakthroughs. Fortunately, the discovery of a plastic-eating bacterium might play a role in this. But till then, we need to be conscious of our own actions, and think before doing anything that may harm nature.

Rana Pratim Sharma
Goalpara, Assam

EXCELLENT EDITION

I read your magazine *Science Reporter* for the first time on the recommendations of my friend. I really liked the cover story on Spare a Thought for Climate Refugees in the June 2016 issue. Climate change is a burning topic nowadays, before giving a thought to the new Pay Commission we should really think about the climate change matter seriously as it can drastically impact our life in the near future.

We have to really think



from the ground level to save our future. The actual sufferers are the climate refugees who are in a pitiable state of not getting any human rights in any of the states they are moving to. I'm really impressed by Aakansha Sharma's cover story.

I was also enlightened by the solutions given in the other article in this edition to mitigate the problem of climate change by Sustainably Managing Waste, Microalgae, Seaweeds, From brown waste to green energy and the Water harvesting. Overall it's an excellent edition that brings together some of the problems pertaining to the environment and solutions for the really big issue of Climate Change.

Sagarika Roy Tapadar
Assistant Teacher
STEM World School, Barrackpore

WAKE UP TO WASTAGE

This has reference to the short feature **Sustainably Managing Waste** in the June 2016 issue. The feature is well written and very important for the so-called modern society. Urbanisation has greatly affected the modern society. Reckless industrialisation has been generating a huge amount of daily wastes within the country. To get rid of the adverse effects of unhygienic wastes, a comprehensive and sustainable waste management system has to be incorporated on priority basis.

Reuse, Reduce, Recycle and Recover are feasible steps to overcome the problems created by wastage hazards.



The environment could be protected by scientific and sustainable waste management concepts. The consciousness among the common people regarding the merits of proper waste management has to be generated and the onus to do so absolutely lies with the educated segment of the society.

Pradip Chakraborty, Nainital

HAVE YOUR SAY

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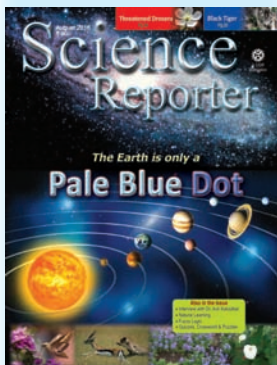
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CHEATING AND PUNISHMENT

Dishonesty, cheating, and fraud are pervasive and expensive problems.

It is estimated that

countries lose anywhere from 1% of GDP to over 10% to frauds, with the largest recent estimate of global fraud costs put at £7.22 trillion, or one seventh of global GDP (Gee and Button, 2013). The Association of Certified Fraud Examiners also reports that a typical organization loses 5% of its revenues to fraud annually, which translates to a projected global fraud loss of \$3.7 trillion.

Dishonesty and cheating have other costs too especially when such acts translate into incompetent doctors, engineers, and sundry other professionals, including even teachers. There have been several studies on what leads people towards dishonest behaviour.

In a study published in the 29 June 2016 issue of Frontiers in Psychology, Yuan Liang and his team from the School of Psychology, Beijing Normal University, China found that increased self-esteem caused a low level of materialism, which in turn decreased corrupt intention. Obviously, the contrary is true as well.

Results of yet another study published in the 2 June 2016 issue of Frontiers in Psychology (Sophie Van Der Zee of the Computer Laboratory, University of Cambridge, UK and team) indicate that rejection causes people to behave more dishonestly, specifically in online settings.

Interestingly, another study indicates that some people may be biologically predisposed to lying, cheating or stealing – much like the scorpion in the old fable that stings the frog giving it a piggyback ride across a river. “Sorry about that,” says the scorpion, as they both drown, “It’s just my nature.”

Published in the August 2015 issue of the Journal of Experimental Psychology: General, the paper co-authored by a team of behavioral economists and psychologists reveals that certain hormones predict the likelihood of whether someone will behave unethically. The study also reveals that among those who do cheat, cheating reduces levels of the hormone associated with psychological stress. In other words, people may use cheating as a means of relieving stress.

So, how does one ensure honest and ethical behaviour? Perhaps by creating mechanisms in organisations and work places that help regulate levels of such hormones in employees. Or, by punishing dishonest behaviour. Which is what happens in paper wasps – dishonesty is aggressively punished.

Paper wasps with more irregular black spots on their faces are more aggressive and are avoided by rivals, compared with wasps with fewer irregular black spots. In a paper published in the 4 July 2016 issue of the Proceedings of the National Academy of Sciences, researchers performed an experiment by setting up bouts between the naturally aggressive wasps and non-aggressive wasps, on the one hand, and between the aggressive wasps and non-aggressive wasps painted to look like aggressive wasps (called bluffers). The researchers found that the bluffers were more violently attacked by the aggressive wasps than the normal non-aggressive wasps – in other words, the degree of punishment for dishonest behaviour was higher.

Punishment does help regulate dishonest behaviour to some extent. But then, there will always be a cuckoo that could get away by deceiving the crow into raising its young by depositing its eggs into the crow’s nest.

Hasan Jawaid Khan

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WELCOME BACK, HIMALAYAN BEARS!

DUE to prolonged militancy, gunfire and poaching, one of the worst hit among the animal species in the Himalayan regions is the brown bear. The 1999 Kargil war witnessed intense artillery shelling and immense loss. One huge repercussion of the situation was the devastation of the natural habitat of the Himalayan Brown bear. This led to the drastic reduction in their numbers, endangering them critically.

An extensive survey by the Rufford Foundation and State Wildlife Department failed to record even a single sighting of the Brown Bear in 2008. By 2012, pugmarks, droppings, scrape marks, and other evidence indicated their presence but sightings were rare. However, they were not in a group or as a family, indicating their sparse numbers.

The dawn of 12 May 2016 brought a new cheer to this beautiful valley. A new hope rose among the high snow-capped mountains – the sighting of a group of brown bears! Wildlife experts sighted a family of three females and their five cubs in the Drass district of Kargil. It took them several hours of trekking through rough terrains at high altitudes when the sighting rewarded them. The spotting, just before dawn on May 12, recorded a maximum number sighted so far – as a group of eight.

Wildlife conservationists and experts are excited as the bears appeared in a family. This indicates that there is a hope of their numbers rising. Multiple female bear population and their cubs also indicate the presence of male bears close by. The possibility of a den in the vicinity is rife.

The Himalayan brown bear is the smallest among the brown bear species found across the world. However, in its habitat it is the largest animal with stocky limbs. This bear is also capable of standing erect on its hind legs and hence happens to be the source of the legend of the Yeti or Dzu-Teh as known in Tibetan.

They are territorial and each bear group has a territory spanning a hundred square kilometres. Their keen sense of smell and nocturnal activity leads them to span a wide area in search of food. Male bears grow up to 5-7 feet while the females are 4-6 feet tall. They are shy and usually avoid human contact except when threatened. The bears hibernate between October to April in caves or dens.

Though they are predominantly vegetarian subsisting on roots and shoots of plants, bulbs, and berries; they are found to be omnivorous too. They also feed on insects, marmots, domestic sheep and goats.

The recent loss of livestock in the neighbouring human habitats gave a hint to the wildlife experts that the bears could be visiting again. Soon a team was set up under the leadership of Intesar Suhail, Kargil Wildlife Warden. This expedition had many surprises in store for them. Firstly, the group was sighted at dawn, which is rare as earlier sightings have been nocturnal. Secondly, the large group appeared at ease and comfort in their surroundings which indicates a growing family. Thirdly, another daytime sighting after two days of a mother and cub rewarded them.

The news has sent waves of enthusiasm for wildlife conservationists, as it indicates a waning of the negative impact of the war. They also surmise that the military activities in the area have brought down the poaching of these animals thereby helping the numbers to grow.

With gradual repair to its ecology, the pristine valley may see renewed hope.

Contributed by Ms Susheela Srinivas, #189, I F cross, 3rd Stage, 4th Block, Basaveshwaranagar, Bengaluru-560079; Email: sushsri@gmail.com

DRONES! STOP PEEKING EVERYWHERE!!

THE use of Unmanned Aerial Vehicle (UAV), commonly known as "Drones", is expanding beyond warfare, from monitoring weather and patrolling borders to conducting search-and-rescue missions and commercial aerial surveillance. The trend of usage of drones in wedding photography is picking up fast. Even farmers are using drones to monitor crop health.

However, the widespread application and adoption of commercial drones has raised several issues pertaining to governance, public safety, individual privacy, ethics and even energy use.

Two Ukrainian tourists were hauled up last year for flying drones over the Amber Fort in Jaipur. After hours of legal consultation, the clueless Amber police had no other option than letting off the tourists with a fine of just Rs 100 for capturing the photography-restricted areas of the fort as the traffic control and air force officials raised their hands, saying that the matter didn't come under their jurisdiction.

In another case, a lensman was arrested for flying a drone with a video camera over the Ajmal Khan Park, a wedding venue in central Delhi's Karol Bagh, when a neighbor lodged a complaint on grounds of breach of privacy.

Many cities in the country including Mumbai and Delhi have banned the use of drones without prior permission as it can put people's lives in danger and can cause a security hazard.

Now, recent research has shown that drones could even imperil animal life in the wild. A team of researchers, from the Unmanned Research Aircraft Facility (URAF) or Adelaide Drone Hub, University of Adelaide, warn in a report published in the Cell Press journal *Current Biology* (Volume 26, Issue 10) about the undesirable and unforeseen impacts of this technology on wildlife.

"Even though an animal might not appear to be disturbed, it could be quite stressed – for example, a bird may choose to remain near a UAV even when stressed because it is incubating an egg or protecting its hatchling," says Mr Hodgson, one of the authors of the report. "It is likely that animal responses show variations depending on a variety of aspects including the species, environmental and historical context, as well as the type of UAV and its method of functioning."

Another study in the journal *Current Biology* (Volume 25, Issue 17), revealed that the heart rate of a black bear hiked pronouncedly when drones flew overhead. When wildlife biologist Mark Ditmer of the University of Minnesota and his colleagues began to study unintended consequences of these aerial vehicles on the animals, they discerned a searing rise in heart rate with every single flyover. In many cases, the cardiac pace doubled, and in the most extreme instances the cardiac count for a mother bear with cubs hopped from 41 to 162 beats per minute.

Meanwhile, in India, the National Tiger Conservation Authority (NTCA) is awaiting a final nod from the Ministry of Defence to start its ambitious drone-monitoring project for combating wildlife plundering and man-animal conflict. The NTCA has sought permission to keep an eye within the boundary of the core area of the forest reserves only. It may not impeach the privacy policy and public safety but how about the possible peril to the tigers?


In an attempt to regulate the operation of unmanned flying machines such as drones, the Directorate General of Civil Aviation (DGCA) is planning to register all civil unmanned aircrafts and issue permits for operating them. The unmanned aircraft shall not be flown over the entire air space over the

territory of Delhi (30 km radius from the President's House) and areas falling within 50 km from international borders. Also, the UAV shall not be flown over other sensitive areas such as nuclear stations, military facilities and strategic locations.

It's time to include forests and wildlife protection zones too in these guidelines to let the wild animals stay in peace.

Contributed by Sonam Chaudhary, Research Intern, Science Reporter, CSIR-NISCAIR, New Delhi





THE RUFIOUS TREEPIE

OCCASIONALLY, the calm and peace of the early morning hours in the serene environment of the Western Ghats is shattered by the cacophony of a noisy bird that decides to pay a visit to the residences at Kovaipudur.

If you venture to go outside to check the nature of this noisy intruder, you may be disappointed. Instinctively, the bird knows that it is being watched, and cleverly conceals itself behind the dense branches of the tree. Now and then this noisy background music will be laced with a melodious call.

The bird is called the Rufous treepie (*Dendrocitta vagabunda*) and you will be

lucky to get a brief glimpse of this beautiful shy bird. It is widely distributed throughout India along with its cousin species, the White bellied treepie. Although it is a member of the crow family, Corvidae, it is much smaller than the common crow (the body about the size of the Mynah, but the tail much longer). Like the mynah, the bird shows variations in colour and size as we go from Kolkata to Kerala.

It has a rich repertoire of calls, some very musical and the others highly cacophonous. It is found commonly in agricultural areas as well as urban gardens. The bird is seldom seen on the ground or the lower branches of a tree. Like other corvids it is very adaptable, omnivorous and opportunistic in feeding. They feed on insects, caterpillars, lizards, young birds and fruits. They also hunt systematically for birds' nests and destroy the eggs and the young of the smaller species. They are

known to hunt along with birds like the black drongo.

Both sexes look alike and they breed during the Spring season. The nest, well concealed by foliage, is built near the top of a tree. Both adults build the nest, a rather small and flimsy cup made with thin thorny twigs. The inner cup is lined with small twigs. It is placed at about 6 to 8 meters above the ground in a tall tree. The female lays pale greenish or bright reddish-brown eggs with darker markings. Both sexes share in building, incubation and care of the young.

The next time you hear some wild chattering in the neighborhood, look for these beautiful birds!

Contributed by Prof. K. Smiles Mascarenhas, Dean of Academic Affairs, Coimbatore Institute of Engineering and Technology, Narasipuram, Coimbatore-641109. Email: smiles51@rediffmail.com)

WORK SHIFTS MAY LEAD TO BRAIN DAMAGE POST-STROKE

REPEATEDLY going in and out of work at different times? Don't have a regular time table? New research suggests that shift work can disrupt internal body clocks, resulting in more severe strokes.

Scientists have long known that rotating work schedules have negative health implications, including obesity and heart problems. A recent study published online on 2 June 2016 in the journal *Endocrinology* shows how this irregular lifestyle can also impact the brain.

"The body is synchronized to night and day by internal biological clocks that tell our bodies when to sleep, when to eat and when to perform numerous

physiological processes," says Dr. David Earnest, a researcher in the Department of Neuroscience and Experimental Therapeutics at the Texas A&M Health Science Centre College of Medicine and lead author of the study.

To understand the effects of altering this cycle, the researchers controlled sleep, and eating patterns in animal models. A group of rodents were exposed to the same daily routine, while another set constantly witnessed changes in day and night. After nearly two months, the team induced ischemic strokes in these animals to see if there was any difference in stroke impact between the two groups.

They observed that rodents who had rotating schedules experienced more severe post stroke consequences, such as increased brain damage, as well as reduced limb movements. The researchers believe that the more extreme effects are not related to working extensive hours or at odd periods of the day. Rather the problems seem to be because the body is unable to regulate or monitor the natural 24-hour circadian cycle:

The team further went on to see whether upsetting internal body clocks resulted in variations in stroke magnitude between male and female animal models. Interestingly, they noticed that younger

CITY DESIGN IMPACTS PHYSICAL ACTIVITY LEVELS

AN international research team, led by public health experts at Queen's University Belfast (Northern Ireland, UK), has conducted the first ever study into the impact of the built environment on levels of exercise and physical activity among people in India.

The research team wanted to examine how the built environment in India plays a key role in enabling or prohibiting physical exercise in the country. Speaking about the study, Dr Deepti Adlakha from Queen's School of Medicine, Dentistry and Biomedical Sciences, said, "Our study is the first of its kind in India, a country where rapid, unplanned and unsustainable urban growth are contributing to increasing environmental and health hazards, greater dependence on vehicles for transport, and diminishing open spaces for walking and leisure."

Dr Adlakha, continued: "India, with a population of 1.2 billion and soon to be the world's most populous country, is experiencing an epidemic of non-communicable diseases like obesity, diabetes and heart disease. Physical inactivity is a major risk factor in the development of these diseases, and the built environment is a key factor in encouraging or inhibiting this."

For the study, Dr Adlakha adapted the Neighbourhood Environment Walkability Scale (NEWS) for urban India. The Scale is an internationally recognised measure to assess residents' perceptions of how the built environment relates to their physical activity, and the study was the first time NEWS has been adapted for use in India.

Conducted in Chennai, 370 Chennai residents were asked questions on their perception of the built environment in their neighbourhood and about their engagement in physical activity. Researchers found that those living in the city felt their physical activity was limited by the city's inadequate infrastructure, poor aesthetics, and limited public transit connectivity.

The respondents outlined several barriers that deterred them from being active. The most common constraints were: traffic, crime, lack of maintenance of the built environment, and poor quality pedestrian infrastructure. Rapid urbanisation, an increase in the amount of traffic, and the loss of trees, parks and green spaces were identified as barriers to outdoor walking.

The research paper, *Adaptation and Evaluation of the Neighborhood Environment Walkability Scale in India (NEWS-India)*, published in *The International Journal of Environmental Research and Public Health* Speaking provides an important insight into how the people of Chennai view their built environment, and how it might be improved or adapted to help promote physical activity.



males had more severe post-stroke effects, in comparison to their female counterparts.

Dr. Farida Sohrabji, another member of the research team, explained how hormonal differences could account for these gender-specific observations: "These sex differences might be related to reproductive hormones. In females, estrogen is thought to be responsible for this greater degree of neuroprotection," she suggested.

Though still in early stages, the implications of this study could extend to human health as well. Shift professionals should routinely check for cardio and cerebrovascular diseases and stay away from other factors known to affect stroke severity such as a high-calorie diet, and smoking.

While it may seem impossible or boring to stick to the same routine every

day, having some sort of a structure may be critical.



Contributed by Arya Mehta 12, Ajanta Apartment,
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A Pale Blue Dot

Humans should stop being narrow-minded, to seek advancement of their own lives while disregarding other organisms co-inhabiting this planet, which is only a pale blue dot on the vast fabric of space.

So, do we really have any privileged position in the universe? For long we believed in geocentrism – the belief that the earth is the center of the universe and all other celestial objects, the sun included, orbit around us, as originally proposed by Ptolemy, the Egyptian astronomer. We believed sunrise and sunset as real.

Geocentric beliefs were shattered by Nicholas Copernicus – the Italian astronomer – who postulated that the earth is revolving around the sun, just like the other planets of our solar system, and that sunrise and sunset are nothing but illusions. This discovery was so profound that sometimes the entire history of humanity is separated into two, pre-Copernican geocentrism and post-Copernican heliocentrism.

NASA took this photograph on a request from Carl Sagan – well-known astronomer and writer – who made the following remark after seeing the image:

"Think of the endless cruelties visited by the inhabitants of one corner of this pixel on the scarcely distinguishable inhabitants of some other corner. How frequent their misunderstandings, how eager they are to kill one another, how fervent their hatreds. Our posturings, our imagined self-importance, the delusion that we have some privileged position in the universe, are challenged by this point of pale light."

ON 14 February 1990, NASA's Voyager-1 spacecraft took a photograph of the Solar System dubbed the "pale blue dot". What is interesting about this image, taken 15 years ago at 6 billion kilometers away, is that the pale blue dot – that occupies not more than a single pixel on this deep space image – is nothing but the planet that we all live in!

"Pale blue dot" (Image credit: NASA)

Earth →



Variations like different colours of flowers and differences in smell are due to random mutations in genes

An analogous phenomenon is easier to comprehend; it is the deliberate choice (selecting/picking) of certain variations by human intervention. Variations like different colours of skin, eye, flowers, differences in smell, size, taste, and so on are due to random mutations in genes.

Of course, for centuries humanity resisted accepting this concept as it would have hurt their egotist self-importance and privileged position. However, that haughty self-importance and elusive privileged position of humanity were completely torn apart with Darwin's theory of evolution through natural selection, first published in 1859.

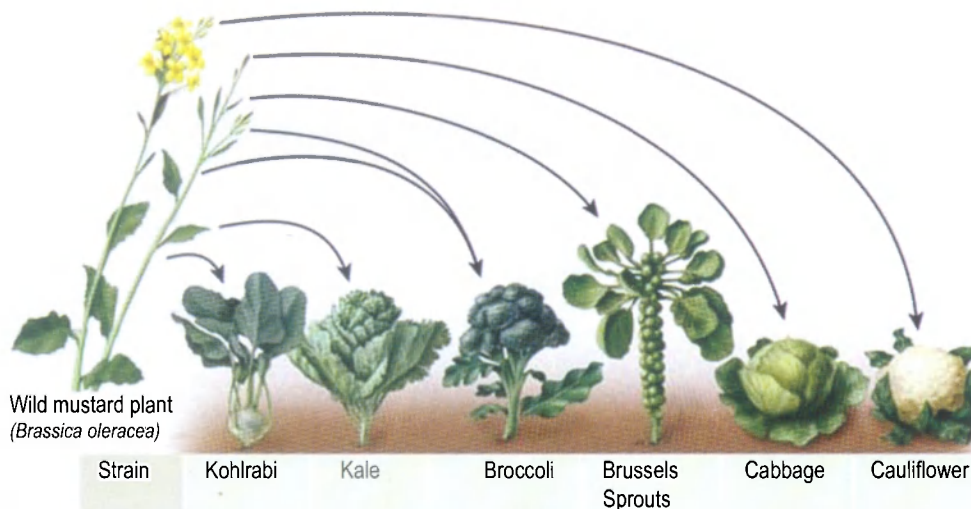
Artificial selection, an analogous phenomenon, is easier to comprehend;

it is the deliberate choice (selecting/picking) of certain variations by human intervention. Variations like different colours of skin, eye, flowers, differences in smell, size, taste, and so on are due to random mutations in genes. But hundreds of generations of deliberate selection of variations and pure breeding have resulted in hundreds of dog breeds that we have today, all of them are indeed evolutionarily related to the wolf – their

ancient ancestor.

Or, look at these vegetables: Cabbage, Cauliflower, Broccoli, Kale, and Brussels Sprouts, these hardly look like each other today, but all have resulted from selective breeding of variants of the original common ancestor – wild mustard plants *Brassica oleracea* – by human beings.

Sometimes artificial selection can be unintentional. In Japan, a popular myth surrounds a crab *Heikea japonica* whose carapace remarkably resembles the face of the fierce samurai. It is said that after Heike – a Japanese Samurai clan of warriors – got defeated by the Meiji, their heads were thrown into the sea, which later turned out to be spirits reincarnated as these samurai crabs. Anglers who catch these crabs, throw them back into the ocean out of fear – a practice that continued for hundreds of years. This unintentional practice helped those crabs with samurai-like marks that were once a rare mutation, to survive and reproduce, and to spread this variation across the population. They were completely avoided by hunters and thus got a greater chance of surviving and reproducing.



Cabbage, Cauliflower, Broccoli, Kale, and Brussels Sprouts have resulted from selective breeding of wild mustard plants



The Solar System

How about the various flowering plants that we have in our garden, like rose, daisy, dahlia, sunflower, and so on? Flowers are reproductive structures of plants analogous to our own genitals. Pollens (male gametes or sperms) of one plant need to get into the pistils (female genitals of flowers) of another plant for their fertilization. For this, the majority of the flowers depend on insect pollinators such as bees, butterflies, moths, etc. Flowers even “bribe” the pollinators by means of honey, scent or colour.

Now, over the years random mutations result in a pool of variants, such as flowers with different colours, scents, sizes, taste, etc. Like a careful breeder who intentionally chooses the most appealing character for him/her, guess who chooses the kind of, say roses, to breed in nature? It is insects! Instead of humans deliberately making the selection, it is nature that selects the “fittest” variant best adapted to the local ecological niche with limited resources.

The environment acts as a sieve through which only the most appropriate variants can pass. While variation is random, its selection is non-random; some varieties are preferred over others and this results in a higher frequency of a particular variety in a population.

Darwin was greatly influenced by Malthus’ *“An Essay on the Principle of Population”* that elaborated how we are overproducing and have limited supply of resources to support this ever increasing demography (Malthus 2013). No wonder Darwin’s theory of evolution revolved around economics.

For example, evolution increases the speed of both predators (e.g. cheetah) and preys (e.g. antelopes), the so called “evolutionary arms race”. Of course, within the limits dictated by the economy of speed with lean and long limbs, versus probability of having a fractured limb if it is too lean and long. Or, increasing height of trees to outcompete its neighbors for maximum light harvest is within the limits set by the economy of higher photosynthesis of tall versus need to invest more resources towards building stronger lignified vasculature for water transportation.

Let us consider Kettlewell’s moths of England. Before the industrial revolution of the eighteenth century, these moths were mostly grey “peppered” in colour so that they could seek refuge (so called camouflage) in the common grey tree lichen. The industrial revolution wiped off almost the entire tree lichen and added black soot – ash-like carbon particles from coal combustion – to the trees. Now that grey peppered moths could easily be spotted by predators like birds and hunted by them, black moths – earlier a rare mutation – survived and thrived.

When conditions improved, trees got



The Samurai crab
Heikea japonica (Image
credit: Pixsharks.com)

Over the years random mutations result in a pool of variants, such as flowers with different colours, scents, sizes, taste, etc. Like a careful breeder who intentionally chooses the most appealing character for him/her, guess who chooses the kind of, say roses, to breed in nature? It is insects! Instead of humans deliberately making the selection, it is nature that selects the "fittest" variant best adapted to the local ecological niche with limited resources.



Flowers even "bribe" the pollinators by means of honey, scent or colour



rid of soot and grey tree lichens returned, natural selection again worked, but this time favoring the grey peppered variety. It is through natural selection that the frequency of black moths increased in the population, and later decreased.

So, evolution has neither any fixed goals (not evolving towards black moths or white moths) nor climbing the ladders of complexity. The process of natural selection works as "the blind watchmaker", as elegantly expounded by Richard Dawkins in his eponymous work (Dawkins 1996).

Next, let's take the example of our coccyx – the tailbone that is a remnant of our ape ancestry. The tailbone is an example of vestigial structures, structures that have lost their original function through evolution. Other examples include vermiform appendix that used to be a cellulose-digesting compartment when we were grass-eating herbivores; goose-bumps, a vestigial reflex to make our body appear bigger by raising the body's hair to scare off the predators, and hip-bone in whales and dolphins that are remnants of their ancestors such as hippopotamus who walk on land.

We now have thousands of fossil evidences that support the evolutionary theory. A number of scientific dating

procedures exist to calculate precisely how old a fossil is, analogous to counting tree rings to date the age of the tree. We can now trace the precise and time-calibrated evolutionary history of a species by sequencing a short stretch of DNA sequence (DNA-barcode) and comparing with DNA sequences from other related species to illustrate ancestor-descendant relationship in a tree-like illustration through a statistical procedure called phylogenetic inference.

This technique has been used to trace dispersal routes of invasive species, find geographical origin of a species, single out a Florida dentist who deliberately infected his patients with HIV (Ou et al. 1992), prove that the Blood Rain phenomenon that happened in South India was caused by spores of an Austrian species of terrestrial microalgae (Ou et al. 1992) and to trace the geographical origin of unknown cadavers by making use of genotypes of gut bacterium *Helicobacter*

Evolution increases the speed of both predators (e.g. cheetah) and preys (e.g. antelopes), the so called "evolutionary arms race".





Black and grey peppered moths on a pollution-free tree. Peppered moth is seen camouflaged in the lichen. (Photo credit: Martinowsky/Wikimedia)

Before the industrial revolution of the eighteenth century, these moths were mostly grey “peppered” in colour so that they could seek refuge in the common grey tree lichen.

The industrial revolution wiped off almost the entire tree lichen and added black soot – ash-like carbon particles from coal combustion – to the trees. Now that grey peppered moths could easily be spotted by predators and hunted by them.

goals, and not climbing any particular ladder, but as dictated by natural selection.

Unfortunately, however, almost the entire knowledge domain of humans seeks to revolve around solving problems faced by only our species. Take for instance, management, politics, international relations, economics, law, and history. Surprisingly, a vast majority of “applied” scientific disciplines also suffer from this fallacy called anthropocentrism (or its glorified synonyms “humanitarianism” and “philanthropy”). For example, medicine, pharmacology, agriculture, aquaculture, engineering, biotechnology, and so on revolve around the central mission to promote human welfare.

In the light of the mediocrity principle, it can be argued that disciplines such as ethology, ecology, evolutionary biology, systematics, taxonomy, biodiversity, etc. should be sculptured by a broader philosophical inquisition. Still broader would be disciplines of climate change, earth science, astronomy, logic, and mathematics.

Humans, therefore, should stop being terribly narrow-minded, to seek advancement of their own lives while disregarding other organisms co-inhabiting this planet, and accept that all organisms have an equal right to the welfare state that is our planet earth – only a pale blue dot on the vast fabric of space.

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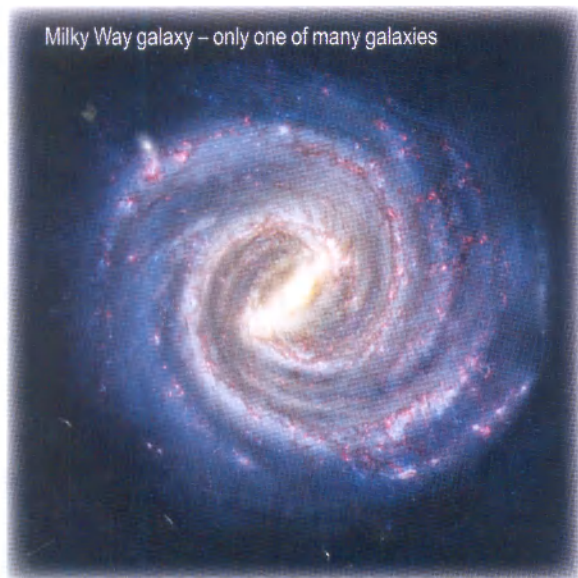
pylori isolated from intestinal mucosa of the dead body (Nagasawa et al. 2013).

A related and complimenting theory in the scientific discipline of paleogeography is that of the continental drift proposed in 1912 by German geophysicist Alfred Wegener. As per this theory, continents of the world continuously drift around relative to each other. The landmass of the earth when it just formed was once a supercontinent, which broke apart forming a number of

smaller continents. Present day continents have been formed from splitting and drifting of the supercontinent Pangea that occurred around 200 million years ago. And after a billion years, the continents of the world could probably rejoin to form another supercontinent (world as one big country with no international boundaries, no place for chest thumping patriotism!).

In the aftermath of the theories of geocentrism and evolution, anthropocentrism gave way to a concept called mediocrity principle. As per this, there is nothing unusual or special about any one particular nation (human-made), human beings (merely one species out of millions of species), earth (one among eight planets of solar system), Solar System (one planetary system out of thousands in the Milky Way, one out of many galaxies), and so on.

New species are continuously being formed (speciation) from earlier species through evolution. Human beings, like any other species, are constantly evolving towards no fixed



Milky Way galaxy – only one of many galaxies



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SHAKUNT PANDEY

The Black Tiger

The increased sightings of black tigers is not a cause for celebration but gives an ominous message that inbreeding depression is putting the existence of the already highly endangered Royal Bengal Tigers at stake.

(Picture courtesy: Orissadiary.com)



The black tiger cub with her white tigress mother "Sneha" at Nandankanan Biological Park, Odisha

ORANGE or yellow with dark or black stripes. That is the usual pattern of the coat of the tiger. Most have also seen or at least heard about the white tiger. But ever heard of a black tiger? Well, you will find one in the Nandankanan Biological Park, Bhubaneswar, Odisha.

The night of 27th July 2014 will always be etched in the history of our

country's Zoological gardens. This day a five-year-old white tigress of the Nandankanan Biological Park named "Sneha" gave birth to a litter of four cubs and of these one was black or most probably a melanistic cub. This is the first instance of a birth of a black tiger cub in captivity in our country and the second recorded instance internationally.

In the early 1970s a black tiger cub was born to a normal coloured tiger couple in the Oklahoma City Zoo. Unfortunately this black cub was killed by its own mother shortly after its birth.

In June 2010, there were reports of the birth of a black tiger cub at Arignar Anna Zoological Park in Chennai. The male cub born to a white tigress had more prominent dark stripes and was hailed as a black tiger. But the Director of the zoo in an email to the author clarified that the tiger cub, who was later christened "Sembian", had a hair coat which had more black stripes than normal white tigers. He was not turning into black as was wrongly reported. Unfortunately this unusual cub died due to infighting with a female.

If white tigers are rare, then black tigers are rarer. Author Hemant Mishra in his work *Bones of the Tiger: Protecting the Man Eaters of Nepal* explains that as is the case with white tigers, the black colour in a tiger is a result of "false melanism" – a process that in the case of black tigers, increases the amount of black pigmentation in the skin.



The Black tiger cub of Okhlahoma zoo that was killed by her mother, is preserved as a curiosity



A normal coloured tiger at the Calcutta Zoo (Picture by author)

The black tiger like the white tiger is an aberration of the Royal Bengal tiger and has no conservation value. It only has a curiosity value and nothing else. The black tiger cub will only increase the footfalls at the Nandankanan Biological Park.

Dr. Lala A.K. Singh, in his paper *Colour Aberration in Tiger: Its biological and conservation implications* offers a more clear explanation: "Normally, the tiger's coat displays a combination of three colours – white, yellow and black. The background colour of the body is controlled by a set of 'agouti' genes and their alleles. 'Tabby genes' and their alleles control stripes. Built within the two series (background and stripe) some genes determine the location-to-location and quantum of expression of three main skin colours – white, yellow and black. The absence of any of these colours or genetic suppression (epistasis) of the effects of genes responsible for their expression leads to colour variation in the tiger."

The various forms of colouration now known in tiger are as follows: 1. Stripesless white; 2. Reduced stripe on white background; 3. 'Lighter' white; 4. 'Darker' white; 5. Golden (pallid), 6. Normal (light yellow); 7. Normal; 8. Normal (deep yellow); 9. Rufous, 10. Brown with dark stripes; 11. Brown without dark stripes; 12. Melanistic; 13. Blue, and 14. Black.

There could have been more aberrations in the colour of the tiger since there is a valid assumption in the fact that

interesting mutations had been wiped out by the trophy hunters before the genes were passed.

Now, why are there now more instances of colour aberration in the tiger population? The answer is recessive (hidden) genes are showing up due to excessive inbreeding caused by habitat destruction of the tigers. The present tiger population roams a smaller area compared to its historic range and due to this there is shortage of mates. This diminishing gene pool is posing a grave threat to the Indian tigers.

A recent research by Welsh scientists has brought to light a shocking fact that the present tiger population in India lacks 93% of DNA which was present in tigers during the British rule! The scientists arrived at this conclusion after comparing genetic data of modern Indian tigers with museum specimens of tigers shot during the British raj and preserved at the Natural History Museum of London.

The territory occupied by tigers has also declined more than 50% during the last three generations and today mating occurs in 7% of its historical territory. The genetic diversity is shrinking and has also become much more subdivided into the small (20-120 individual) populations that

exist today. Their gene pool is not mixing across the subcontinent.

The white tiger population now entirely survives in captivity in Zoos in India and in some international Zoos. Nandankanan Biological Park also holds the Guinness book of world records for having the largest captive population of white tigers which is pegged at 34 specimens.

On the other hand, instances of reporting of black tigers in the wild have increased in the recent past in the eastern parts of our country particularly in Odisha's Similipal Tiger Reserve. Reports of aberrantly coloured tigers started trickling in from the 70s. Beginning in 1975 and 1976, a number of sightings of black tigers occurred. Most of this was ignored as fantasy but an incident on 21 July 1993 brought home the reality.

Dr. L.A.K. Singh cites this incident as follows: "On the 21st July 1993 around 10 am a young melanistic tigress was killed by a boy in 'self defense' with arrows. It occurred in village Podagad in the western periphery of the Similipal Tiger Reserve. The major peculiarity in the body colouration was that on its back the black colour was preponderant. The young tigress had injured '4-5 goats'



Skin of the black tiger displayed at the National Museum of Natural History in 1992

(Picture credit: LAK Singh/Dr. J. Marcan)

...skin of an apparently true melanistic black tiger measuring about eight and a half foot was exhibited at the National Museum of Natural History, New Delhi. This skin, whose origin is not known, was seized from a smuggler in October 1992 from South Delhi.

during the previous one week. Every time it injured a goat the victim was taken away by the villagers. On 20.7.93 night the tigress entered into the cow shed of Sri Surai Besra, 67 years. On hearing some sound Surai went towards the cow shed. The tigress charged at and injured Surai on his face. In the meantime, other members of the family woke up and on shouting the tigress retreated away. The next morning at about 10 am Salku, Surai's son sighted the tigress in the adjoining maize field. The tigress charged towards Salku who ran into his house and from there he aimed at and killed the tigress with three arrows."

In February of the same year the skin of an apparently true melanistic black tiger measuring about eight and a half foot was exhibited at the National Museum of Natural History, New Delhi. This skin, whose origin is not known, was seized from a smuggler in October 1992 from South Delhi.

In March 1997, a melanistic tiger was sighted in the Satkoshia Gorge Sanctuary in the former Dhenkanal district in

Odisha. The Hindu of June 4, 2007 reported presence of three black tigers in the Similipal National Park of Odisha during a tiger census using camera traps. Most recently in June 2012 camera traps installed in the same reserve had captured a tiger with stripes darker than usual.

Black Tigers are not a recent phenomenon because there are recorded instances of sightings of black tigers in our country from time to time. But there was a substantial time gap between these sightings. However, many records of sightings of black tigers were ignored as mere exaggeration or flights of fancy; many recorded instances have even been doubted to be actually sightings of a panther (black leopard) due to its similarity in size. Black tigers have been found to be smaller in size than normal coloured tigers and more similar in size to leopards.

The first recorded sighting of a black tiger in our country was done in 1772 when a black tiger was hunted down in Kerala. The *Journal of the Bombay Natural History Society* (JBNHS)

(year 1889 Volume IV) under the Miscellaneous notes column had reprinted Charles Thomas Buckland's article on an account of a man-eater black tiger of Chittagong (then in Bengal state of imperial India and presently in Bangladesh) which had appeared in the journal *The Field*. Buckland happened to be a Civil Servant of Bengal Civil Service and a keen naturalist and having a major role in the foundation of the Calcutta Zoological Gardens in 1875.

In JBNHS Volume 23 Colonel S. Capper reported a very clear sighting of a black tiger on 11 September 1895 in the cardamom hills of South India. Capper and one C.J. Maltby spotted this black tiger through a telescope and saw it disappearing in the forest. In 1913, A.T. Hauxwell wrote in the JBNHS Volume 32 about the black tiger he shot at Bhamo, Burma (presently Myanmar) but unfortunately failed to recover its carcass.

In 1928 a dead black tiger was also reported from Lushai hills, southern Assam. In the same year another black tiger was shot in the erstwhile united province state of British India.

The black tiger like the white tiger is an aberration of the Royal Bengal tiger and has no conservation value. It only has a curiosity value and nothing else. The black tiger cub will only increase the footfalls at the Nandankanan Biological Park. The normal coloured coat of the tiger has been designed by nature to help it hunt by camouflaging it in its surrounding. How can a black tiger or a white tiger hunt in the wild without being easily found out by its prey?

The increased sightings of black tigers is not a cause for celebration but for pondering on the most vital problem that inbreeding depression is putting the very existence of the already highly endangered Royal Bengal Tigers at stake.

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Natural Learning for a Knowledge- based India

The grassroot initiatives of promoting natural learning through open and flexible knowledge centers can liberate knowledge from the clutches of our rigid education structures and can be proactive steps of reforms towards a knowledge-based India.

MYRIAD mysteries of nature have unfolded over the years driven by the human urge for discovery. Physics has played a major role in this quest.

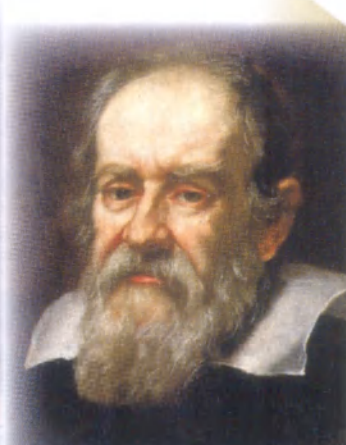
Aimed at understanding nature, physics evolved through the study of time, motion, matter and energy and systematic attempts to bring to fore the interrelations among them to unfold nature's underlying patterns.

The ambitious goal of understanding nature in her totality guided physics to know not just what is seen or reached but also what is unseen and unreached covering extreme diversities like elementary particles and the largest superclusters of galaxies. It brought in its ambit three worlds – the macroworld in which we live, the unseen microworld and the unreached astronomical world. Countless researchers contributed to this evolution through myriad discoveries that decoded secrets of nature and brought to fore how nature 'thinks'.

The early natural philosophers who proposed models about nature included Thales who proclaimed that every event had a natural cause; Leucippus, Democritus and Epicurus who advocated the atomic point of view; and Aristotle and Archimedes who contributed to the understanding of mechanics in nature. The medieval period was mainly dominated by the influence of Aristotle's philosophy. The scientific method was introduced by Roger Bacon during this period as a repeating cycle of observation, hypothesis, experimentation and verification.

A major revolution in scientific thinking took place in the period between 15th to 17th century when Copernicus, Galileo, Kepler and others questioned the established ideas prevalent in astronomy during this period. This revolution culminated in the seminal work of Sir Isaac Newton at the end of the 17th century. Newton's contribution marks the inauguration of the age of reason.

Research work undertaken in the





older sciences known at that time such as optics, acoustics, thermodynamics, electricity and magnetism brought forth some interesting underlying features that were common to all these disciplines. In the mid 19th century, physics, as we understand in the modern sense of the term, emerged as a single discipline that could bind all these disciplines on the basis of these unifying features that came to be understood as the fundamental laws of physics that laid the foundation of physics.

Physics of the 19th century, which later came to be known as classical physics, answered questions of everyday life such as how objects around us rest or move (mechanics), how sound is produced and travels in different media (acoustics), how light behaves in various situations (optics), how heat flows in different situations (thermodynamics), what is the basis of electricity and magnetism and what are the causes behind various observed properties of matter.

By the end of the 19th century, it was felt that physics had discovered almost everything and matured as a near complete science. Lord Kelvin observed, "There is nothing new to be discovered in physics now, all that remains is

TABLE 1. UNIFICATIONS IN PHYSICS

In 1687, Newton unified celestial and terrestrial mechanics by showing that the same basic laws hold for astronomical objects and objects on the earth.

During 1820-30, Oersted and Faraday unified the then separate sciences of electricity and magnetism into that of electromagnetism.

In 1873, Maxwell showed that light is an electromagnetic wave thus unifying electromagnetism and optics.

During 1979–84, Glashow, Salam and Weinberg unified the electromagnetic force and the weak nuclear force into a single electroweak force.

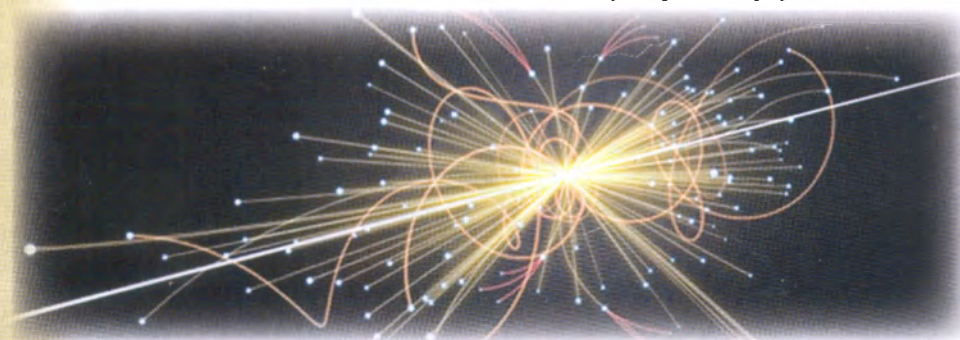


more and more precise measurement." However, this observation proved wrong in the beginning of the 20th century when some new experiments brought forth the failure of many ideas of classical physics on scales too small and too big compared to the domain of our everyday life.

These failures triggered new ideas and fresh insights that marked the beginning of another revolution in physics. Physics of the 20th century, known as modern physics, comprises mainly of quantum physics and

relativity. Quantum physics is the physics of the microworld, the world of electrons, neutrons, photons and a host of other elementary constituents. Relativity is the physics of the cosmic world, the outer world of stars, planets and other celestial objects that are very massive and travel with great speeds, comparable to that of light.

However, all through these pursuits the evolution of physics was guided by the aim to unify the various observed natural phenomena on the basis of their common fundamental features. For example, the root cause of the observation that certain rocks (loadstone) were attracted to one another was understood as magnetism. Similarly, electricity was understood to be at the root of the observation that objects such as amber when rubbed with fur would show similar attraction between the two. However, further research revealed that these two forces were just two different aspects of the same force –



A major revolution in scientific thinking took place in the period between 15th to 17th century when Copernicus, Galileo, Kepler and others questioned the established ideas prevalent in astronomy during this period.



"...what is the source of knowledge? Where do the laws that are to be tested come from? Experiment, itself, helps to produce these laws, in the sense that it gives us hints. But also needed is imagination to create from these hints the great generalizations ... to guess at the wonderful, simple, but very strange patterns beneath them all, and then to experiment to check again whether we have made the right guess."

Richard Feynman (*The Feynman Lectures on Physics*, Vol. 1, Addison-Wesley (1963), p. 1)

electromagnetic force.

Thus, physics connected natural phenomena to their root causes and then also connected these causes together. Einstein's dream of unifying all fundamental forces of nature into a single force could not be realized during his lifetime. However, these attempts are continuing through research in areas such as GUT (grand unification theories) and TOE (theory of everything).

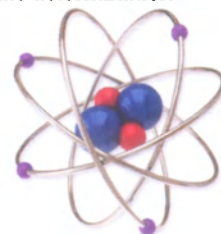
Fascinating Journey of Physics

The evolution of physics is a fascinating account of its long journey dotted with eureka moments of thousands of researchers and of discoveries that came to us as shining pearls in the ocean of knowledge.

physics is like probing the method in the madness of nature. Richard Feynman describes it using the analogy of the game of chess. Nature around us may be likened to be a grand game of chess. The myriad happenings around us are like moves played by nature. Understanding nature means watching this game in order to bring forth the basic rules that govern these moves. The rules that stand the tests of experimentation and consistency with existing well-established science evolve as the laws of physics. These laws are expressed with economy and precision in the language of mathematics and serve to understand the grand chess of nature. Mathematics provides a compact and exact language to describe the order in nature.

Laws of physics are often termed

as laws of nature as they represent the intelligence and predictability in nature. So, all that takes place in nature is in accordance with these laws and anything that is disallowed by these laws can't be a reality of nature. Thus, the laws of physics equip us with the power of prediction; they facilitate determination of the future on the basis of the data about the present. For example, Newton's laws enable accurate prediction of the state of motion of a body at any future instant if the forces acting on the body and the initial conditions are known.

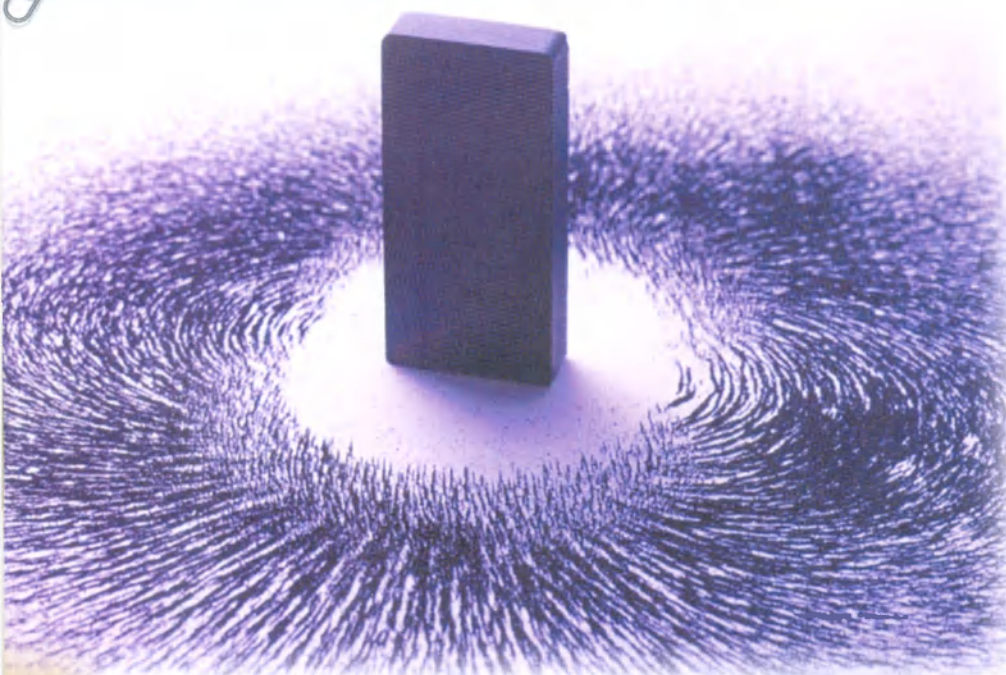


The fundamental laws in physics

Discovering the basic laws of

TABLE 2. EXAMPLES OF RESEARCH OUTPUTS OF CURIOUS QUESTIONS AND THEIR APPLICATIONS

Curious question	Research output	Field of application
Newton wondered why objects thrown up came down. Einstein probed deeper into this question.	Newton's theory of gravitation, Einstein's theory of gravitation	Rocketry, Space Technology
Coulomb asked how charges attract and repel each other. Oersted wanted to know why a magnetic needle kept near a current carrying wire deflects.	Coulomb's law of electrostatics, Theory of electromagnetism	Electrical engineering
Huygen and Maxwell were inspired to know what light is.	Electromagnetic wave theory of light	Telecommunication engineering
Young was interested to understand how light waves interfere. Fresnel was curious to know why light bends round sharp obstacles.	Theory of interference and diffraction of light waves	Interferometry and Diffractometry
Einstein was interested in knowing why electrons come out when light falls on certain metals and probed into how coherent light could be produced.	Quantum theory of light, Theory of stimulated emission of light	Optoelectronics, Photonics, Quantum optics, Laser technology
Raman was inquisitive to know why light passing through a transparent medium undergoes a change in frequency.	Raman effect	Raman spectrophotometry, Raman scanning techniques



are only a few signifying the inherent simplicity of nature. The vastness of physics is due to the myriad applications of these basic laws to a large variety of complex systems in nature.

History of physics convinces us that discoveries are more often results of open enquiries and curious insights into nature and not due to some pre-biased, pre-targeted research. For example, Ampere, Coulomb, Voltas, Ohm, Faraday, Tesla and other pioneers in the field of electricity and magnetism did not aim their research at energizing

the world; they were just satisfying their natural curiosity.

Limitations of Structured Learning

The process of acquiring knowledge, that is, learning, has been traditionally implemented through education structures like schools and colleges. However, the role and design of these structures in facilitating and optimizing learning has always been a subject of debate and discussion and quite often

The rules that stand the tests of experimentation and consistency with existing well-established science evolve as the laws of physics. These laws are expressed with economy and precision in the language of mathematics and serve to understand the grand chess of nature. Mathematics provides a compact and exact language to describe the order in nature.

it is accepted that knowledge provided through these structures leaves much to be desired in fulfilling the needs of one's career and life.

We know that distance is the product of speed and time. Thus with increased speed one can cover more distance in less time. On the other hand with slower speeds one requires more time to cover the same distance. Comparing distance with learning goals and speed with a complex combination of natural propensity and competence based on knowledge and skills, one can find that structured learning compels everyone to reach the same distance in the same time despite widely varying natural speeds.

Thus, the present system comprising of a rigid syllabi, stereotype examination patterns and results based on marks scored in examinations forces a 'one size fits all' approach and smothers individuality. The system goes through a sort of 'pushing syndrome' where students are pushed ahead on the basis of marks considering these as 'official statements' of knowledge and competence. The system thus turns out too many educated and too few knowledgeable products.

Several studies and reports have thus questioned whether knowledge can be synonymous to education with the present system. Table 3 includes some relevant statistics and observations in this regard.

The rigid walls of disciplines, syllabi, examinations, marks, and degrees in these structures are cracking under the pressure of today's knowledge-based world. This is witnessed in the growing emphasis on non-formal and

Table 3. STATISTICS AND OBSERVATIONS ABOUT THE LIMITATIONS OF THE PRESENT SYSTEM

Patents per million population	Researchers per 10, 000 labour force
South Korea 4451	UK 79
Japan 3716	US 79
Germany 2288	Russia 58
US 910	China 18
India 17	India 4
http://www.nature.com/news/india-by-the-numbers-1.17519	
75% engineering students in India are unemployable. (www.thehindu.com/business/75-percent-indian-engineering...)	
• Out of the 48 countries studied, India ranks second last in the U21 rankings of national higher education systems.	
• The relative impact of citations for India is 0.51, which is about half of that of the world average (1.0).	
("Higher Education in India: Vision 2030", www.ey.com/.../EYHigher-education-in-India-Vision-2030.pdf)	

A glowing red sphere with blue and white energy lines radiating from it, set against a dark background.

[illegible]

predictability in nature and is in consonance with the objectives and evolution of physics discussed above. So, the speed decides the time and distance in natural learning instead of the fixed distance and time forced in structured learning. The system based on natural learning thus adjusts to individuality and promotes a win-all situation.

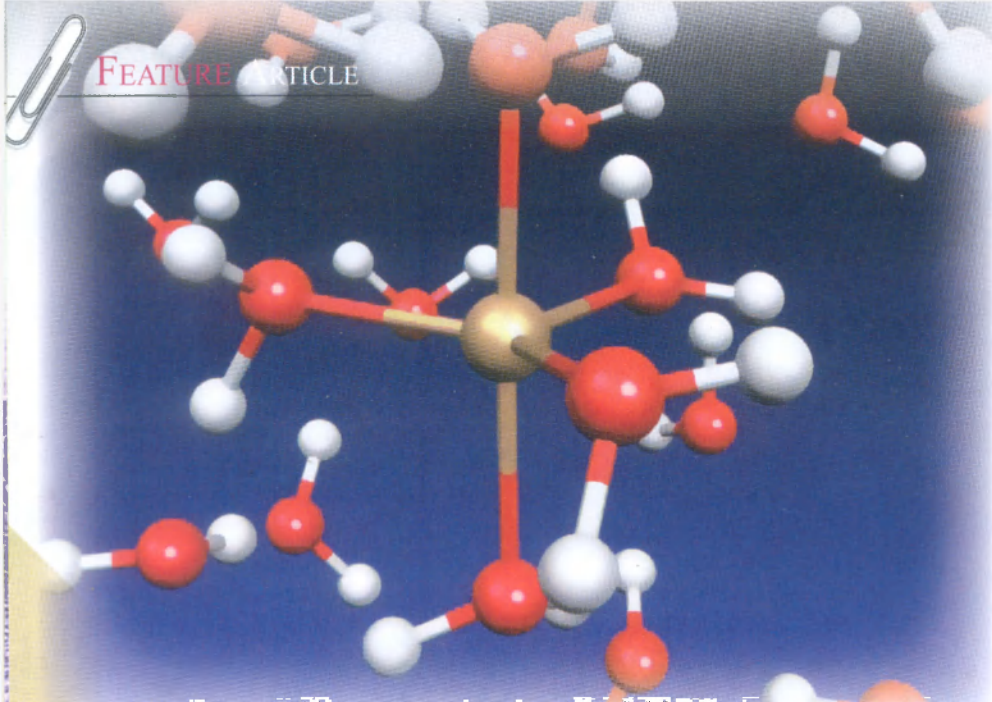
We may call the places that facilitate such learning as “knowledge centers” to distinguish them from the available “education centers”. The syllabi of knowledge centers may be considered in the form of open and flexible knowledge spirals. The depth of a knowledge spiral signifies the knowledge accumulated

through research and the circular area at a particular depth represents the breadth of knowledge at that depth, i.e., the applicability of the knowledge available at that depth for industry or self-employment.

All curricular physics and physics used in industry constitute the breadth of physics whereas new knowledge brought forth through research constitutes the depth of physics. Large number of books, courses and industries related to physics convince us of the vast breadth of physics and the intense research carried out in physics that is disseminated through research journals and conferences remind us of the great depth of physics.

The journey towards gaining knowledge may begin with everyday curious observations or enquiries

Level	Response to the question what is common salt and what it contains
School student	Chemical compound called sodium chloride – dissolves in water, known as NaCl, forms due to ionic bonding of electropositive Na and electronegative Cl...
College student	Crystalline material belonging FCC lattice structure, NaCl structure energetically favoured, energy of cohesion...
Research student	Two-ion quantum mechanical system, linear combination of atomic orbitals, properties, central, non central forces, second, third and higher order elastic constants...



Physics embodies an enquiry into the folded logic of nature. The more layers we unfold by reason, the more layers emerge out confronting us with the vast, unending reserves of nature's knowledge.

of natural phenomena and can then proceed through their refinement to various knowledge domains indicated by different petals of the spiral based on the interests and needs of the learners. The journey advances to more and more complex aspects, current advances and research. The journey can take several routes like breadth to further breadth, breadth to depth, breadth to depth to further breadth and so on giving learners the freedom and facilities of entry, exit and comeback.

As the learners keep climbing the spiral by augmenting their quota of knowledge they find ample scope in both the breadth and the depth of the spiral for pursuit of their natural propensities. Infinite depth and breadth of nature's knowledge has the capacity to accommodate everyone. Each entity of nature contains infinite knowledge and thus learning in this way becomes an unending process. Table 4 illustrates this with an everyday example of common salt.

These responses bring us back to the question, "what is common salt and what does it contain". It contains knowledge, infinite knowledge! The learner takes knowledge from the salt as per his/her capacity.

Scope of Natural Learning

The scope of natural learning encompasses the entire world of matter and energy. Matter and energy are interdependent and interconvertible and their countless interactions result in myriad natural phenomena that we observe around us. These phenomena aroused the curiosity of scientists and led to scientific discoveries.

The omnipresent role of physics is evident if we just glance around, observe an entity and explore it a bit. If the entity is a solid and makes us curious about what makes a solid and how various solids differ we are in the realm of solid-state physics. If it is a rock we are led to petrophysics and clouds lead us to cloud physics. Looking beyond the skies takes us to the realm of space physics and astrophysics and looking into the fathomless seas leads us to branches like ocean physics and naval acoustics. Moving objects take us to dynamics and those at rest to statics. Our interest in 'nothing' leads us to the domain of vacuum physics.

Physics embodies an enquiry into the folded logic of nature. The more layers we unfold by reason, the more layers emerge out confronting us with the vast, unending reserves of nature's knowledge. The exploration becomes a bottomless search; the more we know the more we come to know that there is much more still to know.

The journey towards gaining knowledge may begin with everyday curious observations or enquiries of natural phenomena and can then proceed through their refinement to various knowledge domains.

Towards a Knowledge-based India

Today we are living in a knowledge era. The growth of a knowledge-based world is signified by a marked shift from our dependence on natural resources to knowledge-based resources. This is because natural resources are limited and are consumed when utilized whereas knowledge is not lost when given away and one can have knowledge without depriving others of it. On the contrary, knowledge expands when shared.

India is determinedly marching towards this goal. The vision and mission 2020 of late Dr. APJ Kalam generated a lot of excitement. Then there are some initiatives such as the National Knowledge Commission (NKC), National Mission on Education Through Information and Communication Technology (NMEICT), INSPIRE (Innovation in Science Pursuit for Inspired Research) and the Village Knowledge Center project of the M.S. Swaminathan Research Foundation that are addressing the goal of a knowledge society. But they are woefully short for a country of the size, diversity and youth demography of India.

The grassroot initiatives of promoting natural learning through open and flexible knowledge centers can liberate knowledge from the clutches of our rigid education structures and can be sure and proactive steps of reforms towards a knowledge-based India. Through such reforms basic physics, as a natural philosophy, promises to make us a knowledgeable nation, applied physics, a developed nation and metaphysics, a noble nation.

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A Theorem, A President & A Scientist

What is the connection between the Pythagoras Theorem, US President James Garfield and Alexander Graham Bell? Read on to find out.

President Garfield

LET us start with a question that may be typically asked in a quiz competition. Four US Presidents have been assassinated while in power. Two names are very well known, President Abraham Lincoln in 1863 and President John F. Kennedy in 1963. Who were the other two?

President McKinley was killed in 1901 while serving his second term. And the fourth US President to be assassinated when in office was James Garfield – the 20th President of the USA – who passed away on September 19, 1881 from a bullet injury he sustained when he was shot on July 2, 1881.

But James Garfield is also remembered by the scientific community because he had special interest in mathematics. In 1876, he published a small paper giving a new proof of Pythagoras theorem. Till date this remains the only scientific paper by a US President.

Well, how did this proof appear? Before we answer this question we have to take a look at the very famous theorem of Pythagoras. It states that in a right-angled triangle the square on the hypotenuse is equal to the sum of the squares on the other two sides. A wide variety of mathematicians have provided separate proofs of this theorem over the years – the number has crossed 370.

President Garfield offered a simple but a quite elegant proof of the theorem and published it in the New England Journal of Education (now known as the Journal of Education) in 1876. It was an absolutely new proof in the sense that it did not depend on any other proof to establish the theorem of Pythagoras. You will be able to appreciate how simple it is and the editors of the journal were actually surprised to find that such a simple proof was not offered by anyone earlier.

James Garfield was a Congressman from Ohio, but he was drafted as the

President in 1881. He took charge on March 3, 1881 and on July 2, 1881 when he was going to board a train in the Central Station of Washington DC for his journey to Williams College, his Alma Mater, to deliver a speech he was shot twice by a person from close range. The first bullet grazed his shoulder but the second went inside the body passing the first lumbar vertebra but missing the spinal cord. He was immediately taken back to the White house and the doctors rushed in for his treatment.

At that time X-rays were still 14 years away. The President's injury demanded surgical intervention. Doctors in similar cases always tried to locate the position of the bullet by primitive means. They used to put their fingers inside the wound and try to locate the position of the bullet or any other foreign element that was lodged inside the body. The process was not successful always and war veterans or others who survived the injuries lived with metal pieces inside their bodies.

The induction balance in the form of the first metal detector has undergone wide changes and now ac sources are used to feed the coil and the variety proposed by Bell has limited use. But this was really the first metal detector the principle of which is still being used. President Garfield could not be cured by the innovation of Graham Bell but humanity has benefited greatly.

The first bullet that caused injury on the President's shoulder could be located rather easily and doctors could remove it through surgery. The location of the second bullet was really troublesome as it was lodged deep inside the body. The injury was quite large and painful. The chief doctor in the medical team was Dr Willard Bliss.

The process of sterilisation had just been introduced by a British doctor Joseph Lister. In 1865, he showed proper washing of hands before examining a wound reduced the chances of getting septicaemia to a large extent. He introduced the system in England and was able to show that the exercise if followed along with the sterilisation of surgical instruments could lead to a significant reduction of loss of life after the surgery.

Lister toured USA and delivered lectures to doctors. But it did not impress or convince the whole community and the chief doctor Dr Willard Bliss belonged to this group. Many frontline doctors including Dr Bliss used to consider sterilisation of the surgical apparatus and their own hands as a waste of time. He tried to locate the position of the bullet by putting his fingers in the

wound and did not wash his hands. As a result the wound of the President took a turn for the worse.

Medical bulletins on the condition of the President were being regularly published in newspapers and one gentleman in Boston thought he could possibly help the doctors in locating the position of the bullet with the help of his new invention. His name was Alexander Graham Bell who by that time had invented what in today's jargon is known as the landline – the telephone.

Graham Bell felt that he could locate the position of the bullet in the President's body with an apparatus that he could design by modifying the telephone he had invented. He designed his telephone circuit with small modifications and made a device that we may call the first metal detector. He tried the efficacy of the newly designed instrument first on some animals that

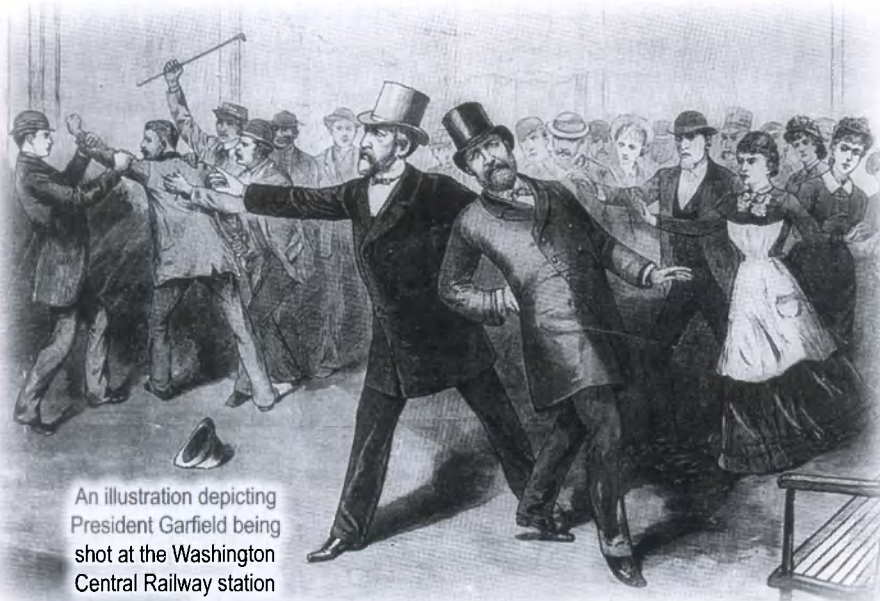
were known to have some pieces of metal accidentally lodged inside their bodies.

Graham Bell's apparatus was essentially an induction balance. There were basically two pairs of coils placed close to each other. The primary coil was connected to a source of power and any change in its current sent a current through the secondary coil. This current while passing through the receiver connected in that part of the circuit reached the listener's end. This way sound from the speaker's end got communicated to the listener's end. In case of a metal present between the primary and the secondary coils, there was a change of flux linkage and a crackling sound was heard in the receiver connected to the secondary coil. Graham Bell wanted to employ this instrument to locate the position of the bullet inside the President's body.

Graham Bell tried to locate the position of the bullet by placing the two coils on the vertically upper and vertically lower sides of the President on July 26 and August 1, 1881. Bell was expecting a change in the current flow in the coil leading to the crackling sound in the speakers. But the set-up failed. And the President died on September 19, 1881.



Garfield as a brigadier general during the Civil War
(Source: www.en.wikipedia.org)



An illustration depicting President Garfield being shot at the Washington Central Railway station

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The failure of the first metal detector devised by Bell was an irony of fate. He could not locate the bullet in the President's body because of two factors. First, the President was placed on a bed with spring mattresses. These mattresses were made of metal and were new. So there was already a metal surface between the two coils placed on the two sides of the President's body, one above his horizontally lying body and the other under his cot. Alexander Graham Bell was not aware of the existence of the metal springs on which the President was lying as these were recently introduced at that time. Because of the presence of this metal between the coils Graham Bell's set-up failed.

Secondly, Graham Bell was compelled to abruptly leave this work and was headed to Boston where his wife was having a difficult childbirth. Bell wanted to come back to Washington DC and to try the whole exercise again but by that time the condition of President Garfield had deteriorated and he was taken out of Washington DC to his country home.

Graham Bell of course soon understood the reasons for his failure. He published his work in a paper in the later

part of 1881 and put forward the idea of what is known as a metal detector. In his paper he also included the incident of the failure of the detection of the bullet in the President's body. The title of the paper was 'Upon the Electrical Experiments to Determine of the location of a Bullet in the Body of Late President Garfield' and 'Upon the Successful form of Inductance Balance for the Painless Detection of

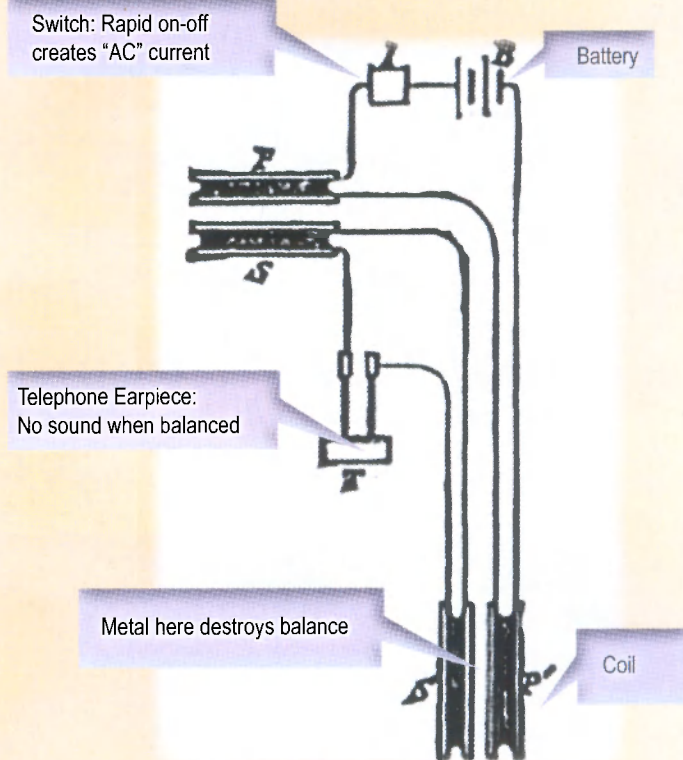
Metallic Masses inside Human Body'. It was read at the meeting of the American Association for the Advancement of Science in its Montreal meeting in August 1882.

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Alexander Graham Bell (standing 2nd from right) visiting President Garfield (lying on the bed) with his equipment. The room on the left had the detectors and Bell's assistants handled them.



One of Bell's induction balances



Bernard Tayler: Physics fails President.
Phys. Educ. 38 63-65 (2003)

(All the photographs have been taken from the slides of a talk delivered at Homi Bhabha Centre for Science Education, Mumbai, by Dean Zollman, Kansas State University USA. Title of the talk was, 'A first attempt in the non-intrusive medical imaging: Alexander Graham Bell and the Assassination of US President Garfield'.)

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Drosera in Danger

The population of Sundew or *Drosera* has been decreasing day by day. There is a need to conserve this carnivorous plant that has several medicinal properties.

THE Sundew plant is well-known for its insect-trapping mechanism. The trapped insects supplement the inadequate mineral nutrition of the soil in which it grows.

Its generic name is '*Drosera*' and in Bengali it is known as '*Suryasisir*', in Hindi '*Mukhajali*' or '*Kandulesa*', in Kannada '*Hula Hidaka guda*' or '*Krimibamdha*', in Marathi '*Davabindu*' and in Telugu '*Burada buchi*' or '*Kavara mogga*'.

Members of the genus *Drosera* occupy a significant part of the Earth's surface and are mainly distributed in tropical old world countries. Members of this genus prefer to grow in seasonally moist or more rarely constantly wet open habitats with nutrient-poor acidic soils (pH 5.2-6.0) and high levels of sunlight. Some such habitats include ferns, marshes and swamps with a small proportion of sand. Many species grow in association with *sphagnum* moss in the bogs and most of the tropical species are mainly found in moist riverbanks (Figure 1).



Figure 1: Sundew thrives on nutrient deficient acidic soil, usually in marshy areas with superficial water flow

Generally, Sundews inhabit warm climates. However, there are reports that some species have adapted to a wide variety of environments, including extreme living conditions. For instance, species like *Drosera burmannii* and *D. indica* even occur in deserts whereas

some other species such as *D. adelae*, *D. prolifera* and *D. schizandra* tend to grow in highly humid and shaded environments of the Australian rainforest. Besides, a few European species like *D. anglica*, *D. intermedia*, *D. rotundifolia*, North American species *D. linearis* and Australian species



Basal rosette of flat leaves studded with thousands of luring tentacles



Countless tentacles topped with sparkling dots of sticky mucilage are usually employed to attract and ensnare insects

D. arcturi, *D. stenopetala*, etc., are frost-resistant temperate species, which form hibernacula (a tight cluster of unfurled leaves) in the winter to overcome extreme cold.

Pygmy Sundews (*D. pygmaea*) show reduced growth and with a dense hairy habit to overcome the extremely dry summer months where they live. For the same reason, some other genera form an underground corm or tuberous stems.

Sundews use their underground stems for water and food storage.

In most Sundew plants, the flowers are held far above the leaf traps by a scape or long leafless stalk. The long scape raises the inflorescence to a height that makes physical isolation of the flowers from the trapper leaves. This adaptation is quite helpful for attracting pollinators to the flowers and to divert the direction of non-pollinator insects to the traps as preys.

The flowers are photosensitive, that is, open early in the morning and close by the afternoon. The entire inflorescence is heliotropic, moving in response to the sun's position in the sky.

Only three species of Sundews are naturally grown in India. Among them Burmann's Sundew (*Drosera burmannii*) is the most common species. It occurs throughout India. Burmann's Sundew is a small plant, normally spanning only 2 cm. The upper surface is covered with sticky glands which trap insects and digest them. It is one of the fastest responding Sundews, and its leaves can curl around an insect in only a few seconds.

Flycatcher (*D. indica*) mostly grows in the Deccan Peninsula, particularly on the western coasts. The plant is naturally found along ephemeral creeks on

Many species of Sundews are widely used as herbal medicines. Its medicinal properties have been traced back to the twelfth century when Matthaeus Platearius, an Italian doctor, described the plant as an herbal remedy for coughs. The parts of Sundew plant used in medicine include roots, flowers and fruit capsules.

sandy soil. The plant can be yellow-green to maroon in colour.

Shield Sundew (*D. peltata*) is mainly found in Northern Indian plains and even on the hills up to an elevation of 3000 m. It grows up to 9-30 cm. Its upper leaves are shaped like shields.

Expert Trappers

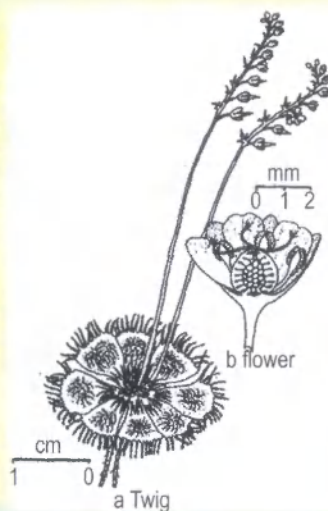
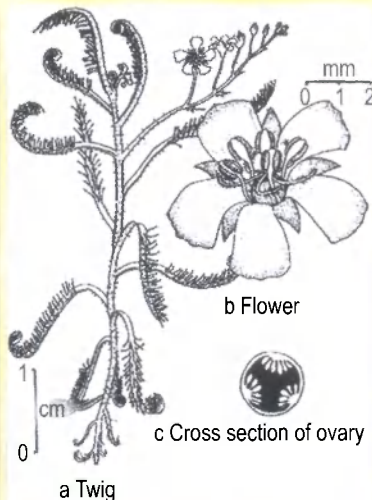
Each leaf of *Drosera* has hundreds of tentacles that hold a gland at the tip. Sparkling dots of sticky liquid are formed by these glands. This probably earns the plant the common name 'Sundew' or 'Dew of the sun'.

Actually there are two types of glands for trapping and digestion purposes. It has been reported that the stalked glands secrete mucilage to attract the prey and enzymes to digest them whereas the sessile glands absorb the final extract after

Only three species of Sundews are naturally grown in India. Among them Burmann's Sundew (Drosera burmannii) is the most common species.



Flower of Burmann's Sundew (*D. burmannii*) which opens early in the morning and closes by afternoon

Habit of Burmann's Sundew (*D. burmannii*)Habit of Flycatcher (*D. indica*)Habit of Shield Sundew (*D. peltata*)

digestion. However, the sessile glands are missing in some species.

The mucilage is very thick and sticky. When a prey, walking as well as aerial insect, gets stuck to the mucilage, more tentacles move in to get their mucilage-tipped glands against the insect to keep it from escaping. The insect usually succumbs to death within fifteen minutes as the secreted mucilage envelops them and clogs their spiracles.

The glands atop the tentacles then secrete acids and enzymes which dissolve the insect. The glands produce certain digestive enzymes like esterase, peroxidase, phosphatase and protease. The sessile glands or the leaf lamina then reabsorb the nutrient-rich extracts.

The leaf tentacles of Sundew plants are extremely sensitive and all the species are able to move their tentacles in response to contact with the prey. It is a kind of chemonasty and some species such as *D. burmannii*, *D. glanduligera*, *D. sessilifolia*, etc., take a fraction of seconds to respond – they can bend their snap-tentacles (outer large tentacles of the leaf lamina) towards the digestible prey. Besides, a few species like *D. capensis* are able to bend their entire lamina just after contact with the prey.

Medicinal Benefits

Many species of Sundews are widely used as herbal medicines. Its medicinal properties have been traced back to the twelfth century when Matthaeus Platearius, an Italian doctor, described the plant as an herbal remedy for coughs. The parts of Sundew plant used in medicine include roots, flowers and fruit capsules.

Traditional healers of Australia and New Zealand use *D. anglica*, *D. linearis* and *D. rotundifolia* as stimulants and expectorants for treating serious microbial infections like leprosy and tuberculosis. Sundew is usually used as a regimen to various respiratory ailments such as asthma, bronchitis, bronchial spasm, cough, lung infection, and whooping cough. Some species of *Drosera* have also been used as aphrodisiac and to strengthen the heart, as well as to cure sunburn, stomach ulcer, and toothache.

Recent phytochemical analyses have revealed that Sundews contain a pharmacologically active naphthoquinone compound plumbagirin. Plumbagin is largely used for healing



Each leaf of Drosera has hundreds of tentacles that hold a gland at the tip.

Sparkling dots of sticky liquid are

formed by these glands. This probably earns the plant the common name 'Sundew' or 'Dew of the sun'.

arteriosclerosis, hyperglycemia and hypolipidaemia. Plumbagin also acts as an immunomodulator that enhances phagocytosis activity of human granulocytes. As a result, Sundew is regarded to be very useful for the treatment of leishmaniasis and malaria.

Sundews also contain certain flavonoids such as kaempferol, myricetin, quercetin, and hyperoside. Such bioactive compounds are supposed to be effective against infertility and quercetin is said to be active against cancer.

Other Uses

Sundews contain rossoliside (7-methyl hydrojuglone glucoside) which inhibits the development of insects, parasitic nematodes and the growth of certain pathogenic fungi. It is also applied as an effective anti-feedant to control insect pests. Moreover, Sundews possess various organic acids, viz., ascorbic acid, butyric acid, citric acid, formic acid, gallic acid, malic acid, propionic acid, etc., and also some other constituents such as carotenoids, resin, tannin, etc., which are yet to be used commercially in cosmetics and other products.

Some species of Sundews, such as *Drosera aliciae*, *D. capensis*, *D. spatulata*, etc., have aesthetic value and are usually sold as ornamental plants in nurseries.

The corms of *Drosera bulbosa*, *D. erythrorhiza*, etc., are gathered as a food source by the aboriginal people of South Western Australia. Besides, a local alcoholic beverage is produced from the fresh leaves of *D. capensis* and *D. spatulata*. In Scotland, a traditional yellow dye is prepared using *D. rotundifolia*.

Threat to Drosera

Some species of *Drosera* are at the verge of extinction and others are facing acute survival problems. One of the major causes of their depletion is habitat destruction. Sundews generally occur in open wetlands and non-forest regions. But the ever increasing pressure of human intervention like urban and rural developmental strategies for agriculture and construction purposes has posed a threat to Sundews.

Moreover, nutrient-rich pollutants from agricultural and household sources move into the habitat of these species, due to which the soil and water chemistry gets altered.

All the species of *Drosera* are protected by law in most European countries where they naturally grow. In addition, all the native species are listed as threatened and/or endangered in Australia, South Africa and North America including the United States.

However, in Asia, surprisingly no species of *Drosera* is conserved by any governmental law. As a result, exporters are collecting species from the wild indiscriminately. Moreover, due to its

ubiquitous medicinal properties, several European countries are importing tropical Asian species of *Drosera* such as *D. burmannii*, *D. indica*, *D. peltata*, etc., for a herbal preparation called '*Herba Droserae*' in order to protect their native endangered species like *D. anglica*, *D. intermedia* and *D. rotundifolia*.

Restriction of the habitat to wetland ecosystem, average rainfall, delayed monsoons and temperature fluctuations throughout the year also influence the life cycle of the Sundews. Sundews also face threats from certain competitive invasive species like *Hyptis suaveolens*, *Parthenium hysterophorus*, and some newly introduced grasses.

Drosera is in peril of being wiped out completely unless corrective measures are taken to conserve it.

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Taking Decisions the Fuzzy Way!

DECISION making is a part of our daily life. Every day we have to take decisions. Some of those decisions are mundane, that is, they have very low impact on our life.

For example, when you set out for your school in the morning, you may have to decide whether to take the umbrella along. The morning may be sunny but there may be a forecast of rain in the afternoon. If we decide to take an umbrella, we may find it cumbersome. On the other hand, if we do not take the umbrella, we may get wet in the rain. Whichever course we follow, the impact of this decision is minimal.

There are some other decisions, however, which may impact you throughout your life. For example, the course or the subject you choose after you finish school, the college you choose to go or the job you finally choose after you have finished college. A wrong decision may adversely affect your future and hence we must decide logically. Keeping that in mind, we should analyze the impact of our decision, refrain from taking decisions emotionally, and apply logic before any decision.

Now, is there a logical way to decide? Fortunately for us there is one using, Fuzzy Set theory and Fuzzy Logic. These ideas were developed for the first time by L.A. Zedeh in 1965. They are being applied on machines and appliances which we use every day. The chips in these machines are programmed on Fuzzy Logic.

What are Fuzzy Sets and how can we apply these concepts for decision making? Let's take a look.

Creating a Fuzzy Set

A set is collection of objects. For example, we can define a set S to be a set of objects in your school bag. This can be written as:

$S = \{\text{Mathematics book, English book, pen, pencil, eraser}\}$

The set will contain names of all the objects in your bag. A set can have numbers as well, for example:

$$N = \{2, 3, 5, 7, 11, 13, 17, 19\}$$

which is a set of prime numbers less than the number 20.

Think of the class in your school. I wish to form a set of boys from your class who are tall. I fix the criterion that if a boy is over six feet tall then I will include him in this set. Applying this criterion I find that only three boys can be included in this set. Therefore, my set T , which is the set containing names of tall boys, would look like:

$$T = \{\text{abdul, raj, john}\}$$

Crisp sets have objects with such well-defined values. The above set T is a crisp set.

Upon closer look, I may find that many boys who are just about an inch or two shorter than six feet have been excluded!

Now, take another example: the set of studious students with the definition that a studious student is one who has secured more than 90% marks in the previous examination. This is another crisp set. The set of studious students thus defined may be:

$$SI = \{\text{ankit, kamla, sonali, monika, yusuf}\}$$

In the above set, we have excluded students who may have secured 89%. They are excluded from this category just falling short by 1%. Such exclusion may not be very useful for our decision making.

To avoid such a situation we define what is called a membership value for each member of the set. Such a set that includes the membership value with each member, is called a fuzzy set. The membership value varies from zero to one.

The membership value of 1 means that the element falls completely in this category, while membership value of zero means that it is out of this category. Thus, we can assign



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membership value of 1 to all members of the set S1. We can then decide that we will assign membership value of zero for those students with less than 50% marks, because they are definitely not studious. For students securing between 50% to 90% we can calculate the membership value, μ as:

$$\mu = (\text{percentage of marks secured} - 50) / (90 - 50) \quad [1]$$

Thus, we can form the fuzzy set of studious students as:

$P = \{(\text{ankit}, 1), (\text{kamla}, 1), (\text{sonali}, 1), (\text{monika}, 1), (\text{yusuf}, 1), (\text{arpit}, 0.98), (\text{bimla}, 0.75), \dots\}$

where we have written the membership value of each member of the set along with the member name. The exact percentage of marks achieved by Arpit can be obtained by reversing the equation [1].

Now you can go ahead and form a fuzzy set of tall boys in your class. We can exclude from this set boys who are shorter than five feet as they are definitely short.

There are more complicated ways of obtaining membership value but for simplicity we restrict our discussion.

Fuzzy Set theory has similar set of rules as in crisp set. We bypass them in this article and turn our attention to the important application of Fuzzy Sets. Fuzzy Sets can be used to make our decisions, particularly those that will impact our life and can't be reversed. Now let's see how we can use Fuzzy Sets to make our decision by two examples as described below.

Choosing the best college: Let us assume that Maya has just finished her school and is interested in pursuing Engineering from a reputed college. Her order of preference for engineering streams is: Computer Engineering, Electronics and Chemical. She first decides the parameters on the basis of which she will make her decision. These are,

1. Rating of the college in the scale 0 to 5, with 5 being the best.
2. Stream offered to her.
3. Distance from home.

The list may not be exhaustive and may contain more parameters, but we limit their number to make the example simple. She forms a table that lists all the parameters for three different colleges which she names as C1, C2 and C3 (Table 1).

TABLE-1			
Parameters▼ Colleges►	C1	C2	C3
Rating	5	4	3
Stream offered (her preference)	Mechanical	Computer	Electronics
Distance from home (km)	800	250	20

The college C1 has the highest rating but has offered Maya Mechanical Engineering which is outside her list of preferences. It is situated at a distance of 800 km which is far from her home. The college C2, which has fairly high ranking of 4, has offered Maya the Computer Engineering stream which is her top preference. It is also at a relatively shorter distance of 250 km. The college C3 which is situated in her home town has the least rating and has offered her the stream of second preference. It seems from the table that the most suitable college that Maya should opt for is C2. Let us see what our Fuzzy Set theory gives as an answer.

Let us form the fuzzy set for rating of the college, R. For rating of 5 we assign a membership value of 1. For the other two members we obtain the membership value by dividing rating by 5. Therefore the set R is

$$R = \{ (C1, 1), (C2, 0.8), (C3, 0.6) \}$$

As you can see the membership value is accurate in reflecting the rating.

The fuzzy set for stream offered (T), can be set up by assigning the membership value for most preferred stream as 1. For the Mechanical Engineering stream we can assign membership value of 0 because Maya does not want to pursue this stream. For Electronics Engineering we can assign membership value of 0.5.

Therefore T will be

$$T = \{ (C1, 0), (C2, 1.0), (C3, 0.5) \}$$

The fuzzy set for distance from home, H can be set up with membership value of 0 for distance greater than 1000 km which is the limit set by Maya. The formula for obtaining membership value can be set up by noting that the college which is at the least distance should have the highest membership value and vice versa. We try the formula,

$$\mu = 1 - (\text{distance}/1000)$$

Therefore, H will be

$$H = \{ (C1, 0.2), (C2, 0.75), (C3, 0.98) \}$$

We can see that the membership value truly represents the distance. The college C3 has the highest membership value while the college C1 has the least.

Next, Maya forms the suitability fuzzy set, out of the three fuzzy sets she has formed earlier. The suitability fuzzy set will have membership values which are the least of the sets R, T and H. Thus the suitability fuzzy set is

$$S = \{ (C1, 0), (C2, 0.75), (C3, 0.5) \}$$

The best choice can found by choosing the member with highest membership value in the suitability fuzzy set, which in this case, is college C2.

Choosing the best job offer: Let us assume Ram after completing his college has received three job offers. He is a little confused about selecting the right job.

The first step is to list the parameters on which he will select the job. He lists the parameters:

1. Salary or remuneration
2. Stability
3. Future prospects

In the table below, Ram has listed the parameters for the three job offers which he names as J1, J2, and J3.

TABLE-2

Parameters▼ Jobs▶	J1	J2	J3
Salary p.m.	60 000	75 000	100 000
Stability	very stable	fairly stable	unstable
Future prospects (no. of years for next promotion)	7	2	2

The job J1 is a government job, and therefore it is very stable but is least remunerative. Job J2 is from a large company, therefore it is fairly stable with fairly good remuneration. The job J3 is from a startup company, is therefore least stable, but comes with a large pay packet. The criterion of future prospects can be ascertained by knowing the minimum number of years that one has to spend after joining, to obtain the next promotion. We assume that Ram has found out that the number of years required for next promotion to take place are 7 years, 2 years and 2 years for the jobs J1, J2 and J3 respectively.

Now we have to form the fuzzy sets for the three parameters. Let us first form the fuzzy set for remuneration, R. The membership values can be obtained by noting that the maximum salary offered is Rs. 100000. We can choose membership value of 1 for this member. For the other two jobs we can obtain their membership value by dividing the salary offered by 100000. Thus, for the job J1 the membership value would be 0.6 and for the job J2 this will be 0.75. Therefore we can write R as:

$$R = \{ (J1, 0.6), (J2, 0.75), (J3, 1.0) \}$$

Next we have to form the fuzzy set for stability, T. Here we don't have any numbers but we can assign membership value of 1 to job J1, considering that it is a government job. For J2 and J3 we can assign values of 0.8 and 0.3 respectively. Thus we can write T as:

$$T = \{ (J1, 1.0), (J2, 0.8), (J3, 0.3) \}$$

Finally we set up the fuzzy set for future prospects, F. We note that the membership value should be highest for the job that has least number of years required for next promotion. For this to happen we improvise the formula,

$$\mu = 1 - (\text{no of yrs} / \text{max no of yrs}) \quad [2]$$

We choose the maximum number of years that Ram can wait for next promotion to be 10. By applying the formula we obtain F as

$$F = \{ (J1, 0.3), (J2, 0.8), (J3, 0.8) \}$$

After having obtained the three sets for the three parameters, we have to form the fuzzy set of suitability, S. This set will have membership value which will give suitability for each one of the jobs. The suitability membership value can be obtained by extracting the least value of membership for each one of the jobs from the sets R, T and F. therefore the S is given as:

$$S = \{ (J1, 0.3), (J2, 0.75), (J3, 0.3) \}$$

Now the most suitable choice is the one with highest membership value which in our case is job J2.

Try this method to decide upon the best gift that you will offer to your brother or sister on his/her next birthday.

r. Atish Mozumder retired as a teacher from the Delhi College of Engineering. Address: H-1531 Chittaranjan Park, New Delhi-110019.

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Science Reporter

M.P. RAMACHANDRAN

Omnipresent Mathematics

Mathematical concepts play a great role in several applications ranging from satellite tracking to sports and even clinical diagnosis and treatment.

MATHEMATICS has several features to support many applications in varied human endeavors. Let's begin with geometry. And let's take the circular wheel as the first example.

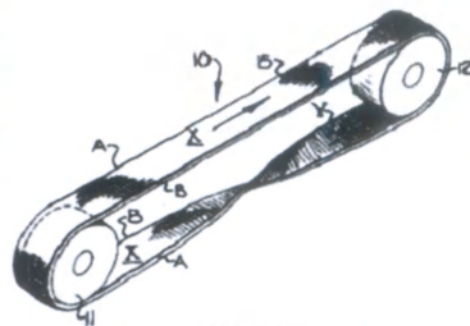
The circle was first used and probably the explanation came later to realise the advantage. The circle has more uniformly varying tangent directions over the entire surface. The mathematical property is the essential part of the goal and even today no change has been made to it even while racing in a F1 circuit for a huge price tag.

The next application is an equally marvelous one – the shape of the common antenna reflector. It enables commanding and receiving signals from a spacecraft out in space. The shape of the reflector is a paraboloid. It evolves from the fact that a parabola redirects all its rays parallel to the focal line to a point on it called the focus. It is here that the feed is placed to collect the microwave energy. The energy is enhanced by keeping a hyperboloid and then collecting the energy at its focus. The data comes in the microwave. The assumption is that electromagnetic waves from far travel in straight lines.



NASA's Deep Space Network Antenna at Canberra. It has a Paraboloid and Hyperboloid combination.

Mobius Strip: One more geometrical shape that has gone to the level of patent registration is the Mobius strip. It has one surface due to the twist. B.F. Goodrich Co. thought that by making the surface(s) fit for rough use the life of the conveyor belt gets extended. Without this twist the only surface shall wear out faster.

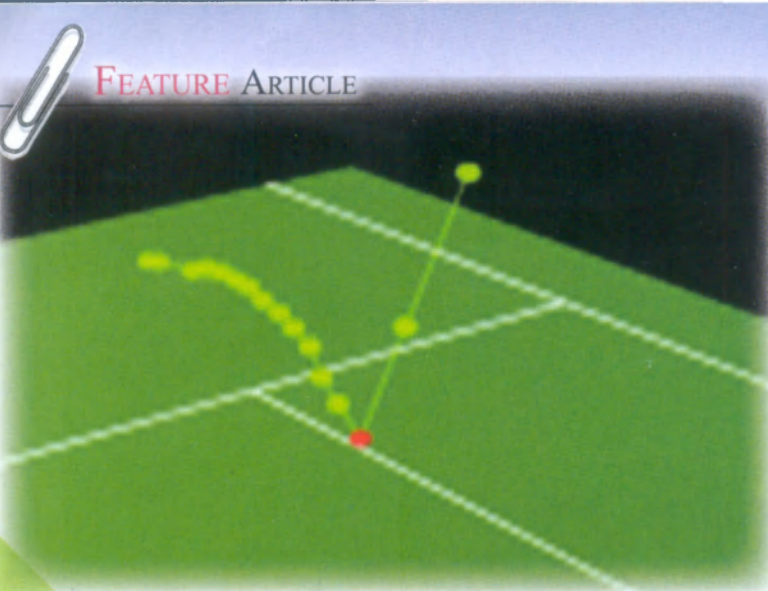


Mobius Strip

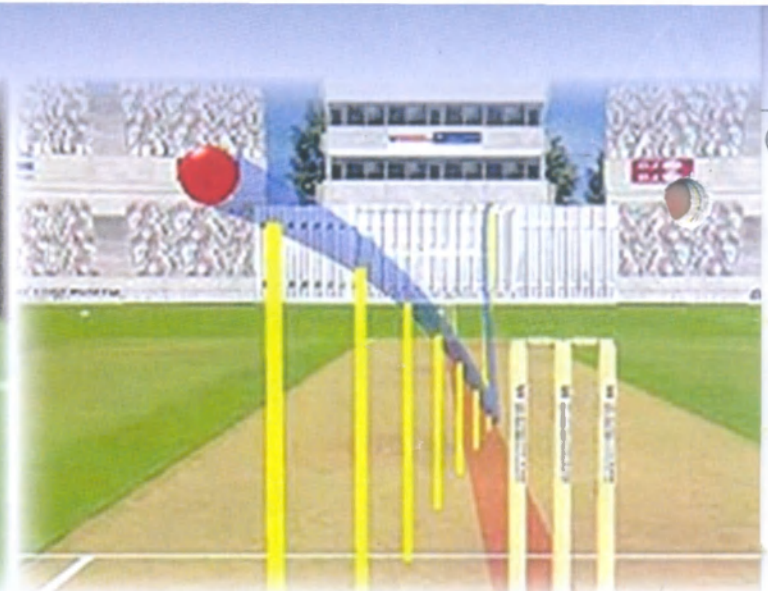
Another use by the virtue of this unique geometrical shape is in the design of an electromagnetic resonator. This application is for those who are familiar with electronics.

Algebra: In algebra, the first application is in digital communication. Reed-Solomon encoder makes use of algebraic forms as a code generator. It is used in the encryption of commercial data broadcast from a satellite wherein the key is provided to the valued customer.

Another case is that of cubic convolution interpolation. This is an



Tracking ball position



Course of a cricket ball

The sports industry has today a huge amount of money at stake. Tennis and badminton too have become great money-spinning games today. Both the games have some tense moments – whether the ball has touched the ground out of the border line or not. The truth is arrived at by looking at replays.

The replay shows a slow animated motion on an imaginary ground and depicts the truth. Data from more than two cameras is at work yet the vital process is triangulation. Triangulation is also an algebraic equation solver to determine the ball in three-dimensional space.

algebraic expression that has nearly 1800 citations – a huge number in the realm of mathematics. The simple algebra enables better visualization of a sub-sampled data, say, that might have been sent from the camera electronics system onboard a spacecraft or be tween any two systems on the earth. Sub-sampling reduces the data size and enables fast and effective transmission while convolution re-captures the suppressed data. It also helps to zoom the data and read between pixels! What an interesting nexus.

Most mobile phones today have a GPS receiver. It gives position information which is accurate within 3 meters. The input data to this is from the 'visible' GPS satellites. The process is trilateration – an algebraic manipulation. When the GPS receiver is good, more GPS satellites are visible and that makes the position computation more accurate. The core part is in the algebraic elimination to derive the spatial position in multiple ways.

The sports industry has today a huge amount of money at stake. Tennis and badminton too have become great money-spinning games today. Both the games have some tense moments – whether the ball has touched the ground out of the border line or not. The truth is arrived at by looking at replays. The replay shows a slow animated motion on an imaginary ground and depicts the truth. Data from more than two cameras is at work yet the vital process is triangulation. Triangulation is also an algebraic equation solver to determine the ball in three-dimensional space.

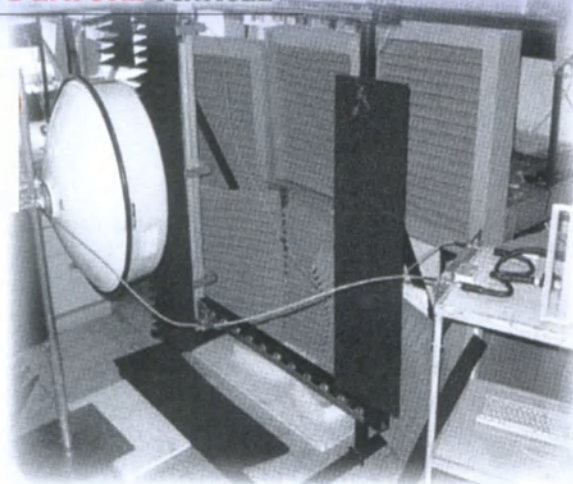
Commonly, derivative usage comes in engineering data with noise. Noise describes the lack of quality in the data. The processor where this data is fed has an algorithm that does the trick and finally determines a 'good derivative'. It can help in deciding if a player is LBW. Six cameras, with 100 frames per second, which first ends with the ball impacting on the pads. To get the future course of the ball from the pads, successive frames

near the pads are used and this helps to derive the velocity. It may be noted here that position alone is measured by a device and velocity is then derived as per the Heisenberg uncertainty principle. It then confirms whether the ball finally went to rock the standing stumps.

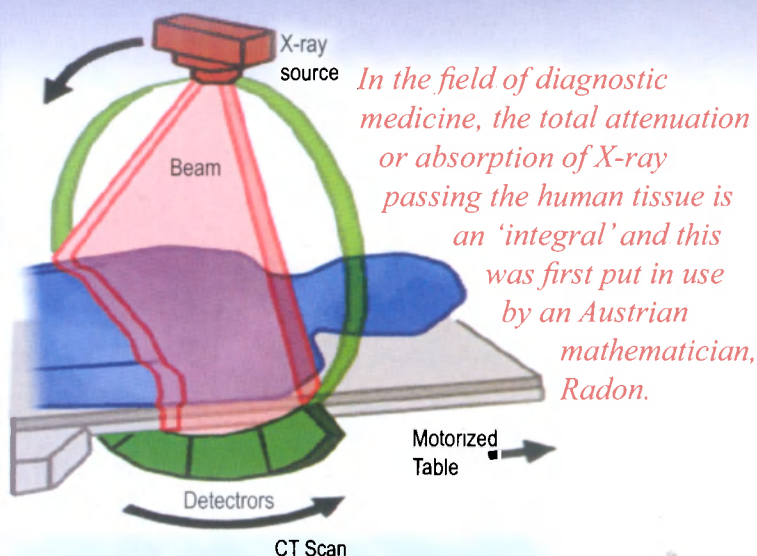
This indeed is similar to the case of orbital propagation of a satellite and confirming a rendezvous with a planet. The ground station tracks the satellite and using the measurements estimates the orbit which is position and velocity. However, the propagation (like from near the pads) here is more influenced by the gravitational force unlike the ball hitting the stumps.

And next we look at satellites. In determining the orbit of satellite, it is first tracked by using the ground earth station and ranging is carried out. This uses the signal emitted by the satellite to the earth, which is called range measurement. Range measurement of satellite is also replaced with a return signal capability in the ground system, that is signal from the ground goes to the satellite then turns back to the ground station.

Here we can perform a correlation between the signal that was sent and the signal that was received. The correlation enables estimation of the Doppler shift. This shift in frequency is caused by the fast moving satellite – a relativity effect. The thing that made the difference is that the estimate of the shift is actually the derivative of the phase difference between the to and fro signal. The knowledge of the phase then leads and enhances the accuracy in knowing the satellite position at least by a more than one order. Such systems are useful for critical missions.



Near-field measurement set-up



In the field of diagnostic medicine, the total attenuation or absorption of X-ray passing the human tissue is an 'integral' and this was first put in use by an Austrian mathematician, Radon.

Integral: Curve fitting is a common road travelled by many engineers. Sometimes the accuracy of the fit is no more important than its "smoothness". The integral of the second derivative is a factor that gauges the smoothness. A judicious choice of this and the mathematics that followed gave birth to the splines. Lots of applications came up after the car surface design for Renault and Citroen was carried out using splines.

The integral finds a formidable place thanks to Fourier transform. In antenna test set up it is essential to obtain the far-field pattern. This is because the beam is usually received at distances that are far away, in line with far reaching communication. The beam is the energy pattern of the antenna system and decides the design the antenna. The satellite

antenna beam footprint falls on the earth. But this should not fall on the neighbor's land. A very simple way to know this is by taking a Fourier transform of pattern measured in the near-field. This can help to characterise even complicated antenna. Near-field are small distances. The room where this test is carried out is small and disturbances are diminished by suitable precautions and this makes the measurement accurate. Long ranges are expensive to maintain.

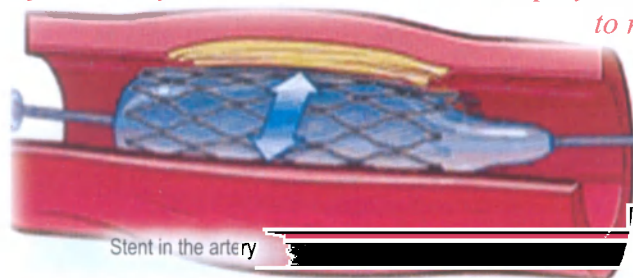
In the field of diagnostic medicine, the total attenuation or absorption of X-ray passing the human tissue is an 'integral' and this was first put in use by an Austrian mathematician, Radon. The CT scan is a very reliable health diagnostic method. This attenuation principle and integral is also used to study the atmosphere.

This happens when a GPS receiver on a low earth orbit receives the GPS signal that gets bent due to the atmosphere.

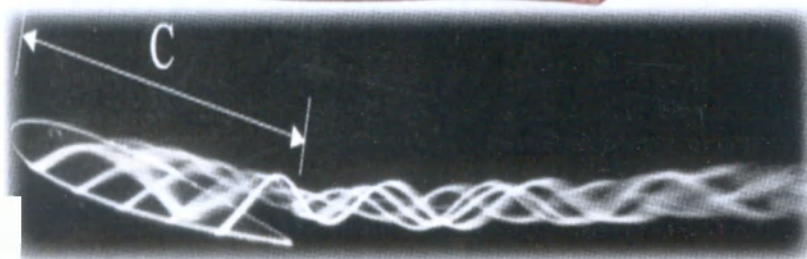
A type of integral equations is Prandtl's theory of finite wing span. The lift and drag being represented as an integral, the formulation ends up as an integral equation. Given the chord of profile as well as the velocity of air flow at infinity and its geometrical angle of incidence, the solution of the integral equation is about circulation of air flow around the profile. Many wing designs have been analysed using this approach.

The integral equation is also used in preventing the re-blocking of the artery stent. In the stent there is a polymer region designed to release drugs. An integral equation of Volterra type is deduced and the solution is the release conditions.

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integral equation of Volterra type is deduced and the solution is the release conditions.



Flow past a finite span

Differential Equations: The Law of Malthus has helped early thoughts on economy. His idea was that the rate at which a natural population grows is proportional to its current size. This statement modified by Verhulst, where the population encounters internal competition. The solution of the differential equation convinced the critics. Better models followed later.

Another important differential equation that received wide attention in the field of stock pricing is Black-Scholes partial differential equation.

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Healthy Barley

WITH changing lifestyles and increasing urbanization, diseases like coronary heart disease and diabetes are on the rise the world over. Barley, with its rich dietary fiber elements such as Calcium, Magnesium, Phosphorus, Copper, Zinc and Fe has a beneficial effect on blood cholesterol (LDL; low density lipo-proteins) and blood glucose and thus lowering the risk of cardio-vascular diseases.

Health conscious consumers tend to use increasingly novel, valuable grain sources and products in their diets. Blends exploiting favorable attributes of barley may be a suitable way to use this valuable crop. Extensive and widespread research as well as awareness is needed to utilize the potential food uses of barley, as its nutritive value is analogous to the other cereals especially widely consumed wheat as well.

Barley (*Hordeum vulgare* L.) accounts for 7% of the world's entire cereal production and is at fourth position in the grain production after wheat, rice and corn. It is called *Jau* in Hindi, Marathi, Urdu and Punjabi. Barley is predominantly consumed as food crop in the semi-arid regions of Africa (Morocco, Algeria, Libya and Tunisia), Middle East

(Saudi Arabia, Iran, Iraq and Syria), highlands of Nepal, Ethiopia and Tibet, Andean countries of South America (Peru and Chile) and in some Asian countries (China and North Korea).

Wheat was a pricey grain and not easily available in the Middle Ages, thus making barley and rye some of the key ingredients in preparing bread in Europe. Barley meal, a whole meal barley flour lighter than wheat meal but darker in color, is used in porridge and gruel in Scotland.

Barley grains possess higher amounts (3-7%) of a dietary fibre called beta glucan (β -glucan). The mixed linkage (1-3; 1-4) beta glucans have been shown to lower blood glucose and lower the LDL cholesterol and is approved in many countries as health benefitting soluble fibre.

Barley is also a rich source of tocopherols, including tocopherols and tocotrienols, which are known to reduce serum LDL cholesterol through their antioxidant action.

BARLEY GRAIN PROXIMATE COMPOSITION IN COMPARISON TO WHEAT

Constituent	Percent composition in Barley on dry weight basis	Percent composition in Wheat on dry weight basis
Crude protein	7.50-11.49	10.60-12.70
Crude fibre	4.32-6.13	0.84-2.30
Crude fat	2.33-7.90	1.46-3.73
Moisture	7.41-12.45	10.40-13.60
Starch	51-55	74-78.6
Total Dietary fibre	12.62-13.50	8.52-10.10
Insoluble Dietary fibre	9.55-11.20	7.84-9.25
Soluble Dietary fibre	1.74-2.90	0.42-0.49



Barley has more dietary fibre and protein content as compared to other staple cereals especially in comparison to wheat and it is very cheap and easily available all over the world.

The range of potential nutritious advantages in consuming barley is extensive. Hull-less barley has been investigated for several potential applications as whole grain and for its value-added products. These include bran and flour for multiple food applications, flakes similar to oatmeal, and grits.

Barley supplementation can significantly improve dietary fibre content, total and ionisable iron content in all the products. Products prepared from roasted flours show an improved starch and protein digestibility with decrease in phytic and polyphenols. Research reports have indicated increase in protein and reducing sugars on roasting of barley grains/flour whereas moisture, crude fiber, ash and non-reducing sugars reduced.

Potential Health Benefits of Barley

- Hulled, pearled, and hull-less barley grain all contain beta-glucan, a source of soluble dietary fibre that is responsible for lowering cholesterol. The Food and Drug Administration (FDA) ruled in 2006 that barley foods may carry a health claim specific to soluble fiber and coronary heart disease. Barley can reduce the total cholesterol and low-density lipoprotein or LDL, apart from inhibiting the harmful oxidation of bad cholesterol.

- Barley contains eight essential amino acids. Eating whole-grain barley can regulate blood sugar compared to white or even whole-grain wheat, which have similar glycemic indices. The effect was attributed to colonic fermentation of indigestible carbohydrates.

Non-alcoholic drinks such as barley ter and barley tea (called *mugicha* in Japan) are made by boiling barley in

water. In Italy, barley is also sometimes used as coffee substitute, *caffè d'orzo* (coffee of barley).

- Barley is a powerhouse of phytonutrients that can guard the body against the risks of breast and prostate cancer due to the production of estrogen-like effects.

- The trace mineral, selenium, is present in the body and it is necessary for cell protection and hormone efficacy. This element acts as an antioxidant, thereby protecting the male reproductive system by producing a protein that protects sperms from oxidative damage. Selenium is also helpful in preserving elasticity of the skin by protecting it against free radical damage. The heart, immune system, pancreas and tissues are protected and reduction in the risk of cancers of the skin, colon, stomach, liver and breast.

- Barley distributes the amino acid, tryptophan throughout the body, thereby inducing sleep, regulating moods and helping the body to relax.

- Manganese and B-complex vitamins, found in barley, are essential for the overall well-being of an individual. They promote normal bone production and eliminate the iron deficiency from the body.

- Barley is known to improve the circulatory system and protect it against chronic diseases like arteriosclerosis.

- Barley is also a rich source of tocopherols and tocotrienols, which are known to reduce serum LDL cholesterol through their antioxidant action and reduce toxins in the body by supporting its gentle detoxification.

- With the presence of digestive enzymes in barley, this cereal grain helps in getting rid of toxic and indigestible materials from the body and alleviating

the symptoms of stomach ulcers and other digestive conditions.

- Fiber-rich foods, like barley, are helpful in creating a feeling of fullness between meals and thus, reducing constipation. Besides, digestive problems such as indigestion, food allergies, and gastro esophageal reflux disease (GERD) can be successfully alleviated with the intake of barley.

- This grain helps in the initiation of skin cell growth, which is useful in treating diseases and ulcers on the epidermal layers, due to its antibacterial and antioxidant properties. Barley also contains vitamin C and carotenoids, both of which are essential for rejuvenating mitochondria in the skin cells and giving it a youthful look.

Barley has more dietary fibre and protein content as compared to other staple cereals especially in comparison to wheat and it is very cheap and easily available all over the world. It also reduces the risk of various diseases such as obesity, cardiovascular diseases and diabetes. Because of their complementary values, blending wheat, oats and barley may provide good results and effective solution for large scale utilization of barley for human consumption.

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INTERVIEW



Gauhar Raza: "Atomic physics" reminds a common citizen of the Second World War, Manhattan Project, Hiroshima & Nagasaki and modern nuclear disasters such as Three Mile Island, Chernobyl, and Fukushima. What images come to your mind when somebody talks of atomic energy?

Anil Kakodkar: Well, I was fortunate enough to spend an entire professional career, five decades, associated with atomic energy. I have seen the phases in which this program has evolved from the early beginnings.

Gauhar Raza: Long time ago I was talking to Dr. Homi Sethna, he said that when he started the programme with Dr. Homi Jehangir Bhabha, we knew almost nothing, but the nation had given us the mandate to do it and we as scientists took up the challenge and installed structures and mechanisms. How do you feel when you look back at the beginning of atomic energy in India?

Anil Kakodkar: Well, thanks to the great vision of Dr. Bhabha and the efforts put forward in his time, programmes on atomic energy particularly at the Bhabha Atomic Research Center, Trombay that followed the Tata Institute of Fundamental Research (TIFR) were essentially to develop nuclear technology capability in the country. He did this with a very comprehensive outlook and so at BARC he collected groups of scientists to deal with the whole canvas. He then put forward a broader roadmap for the related programmes. This created the opportunity for many to take up challenges and progressively deliver.

Gauhar Raza: Dr. Kakodkar, when did you take the decision to go into physics and that too nuclear physics?

Anil Kakodkar: Well, my getting into Nuclear Science and Engineering really



*"Think independently
to derive independent
solutions":
Anil Kakodkar*

happened after I joined the BARC Training School. I literally found the right environment for all that I wanted to do. It was around the time when nuclear energy had evolved significantly in some countries. In India, it was in its infancy. Many discussions took place at the conceptual level to visualize how the configuration of Indian Nuclear Reactor should look like and that really gave me a wide open field in terms of putting ideas into practice.

Gauhar Raza: Do you agree we are unable to understand fusion and that therefore nuclear energy has not done what it was supposed to do?

Anil Kakodkar: You are partly correct. The actual problem is that nuclear energy has to compete in the marketplace to deliver as a major source of electricity. Now, let me take the example of England. There was a time when nuclear energy was rapidly developed in UK and then the North Sea find happened. Progress on the nuclear energy front stagnated thereafter. Now, for the last five-six years, there is a realisation that North Sea source of energy is exhausted and so there is a renewed interest for nuclear energy in UK. This is despite the Fukushima disaster and the 'Chernobyl Public opinion in UK has been strongly in favour of nuclear. So the question is about energy alternatives.

Dr. Anil Kakodkar (born 1943) was the Chairman of the Atomic Energy Commission and Secretary, Department of Atomic Energy, Government of India.

After passing out from Ruparel College, Mumbai, Dr. Kakodkar obtained a BE degree in Mechanical Engineering (1963) from the Veeramati Jijabai Technological Institute (VJTI), Mumbai University. In 1964, Dr. Kakodkar joined the Reactor Engineering Division, Bhabha Atomic Research Centre (BARC). While working at BARC, he obtained a Master's degree in Experimental Stress Analysis from the University of Nottingham (1969). In 1996, Dr. Kakodkar became Director of BARC. He was Chairman, Atomic Energy Commission during the year 2000 to 2009.

Dr. Kakodkar played a key role in the design and construction of the Dhruva Reactor, a completely original high-tech project. Utilization of India's vast thorium resources for energy production has received special attention under Dr. Kakodkar's leadership. He has led the indigenous development in India's Pressurised Heavy Water Technology.

Dr. Kakodkar was part of the core team that worked on India's Peaceful Nuclear Tests in 1974 and 1998.

He has played an instrumental role in the establishment of many scientific institutions in the country including National Institute of Science Education and Research (NISER), Department of Atomic Energy (DAE)-Mumbai, University Centre for Basic Sciences and Homi Bhabha National Institute.

Dr. Kakodkar has received many awards including Dr. Vikram Sarabhai Research Award (1988), FICCI Award for outstanding contribution to nuclear science and technology (1997-98), Dr Y. Nayudamma Memorial Award (2002), Gujar Mal Modi Innovative Science and Technology Award (2004), Padma Shri (1998), Padma Bhushan (1999), and Padma Vibhushan (2009).

He is a Fellow of the Indian National Academy of Engineering, Indian Academy of Sciences and National Academy of Sciences, India. He is a Member of the International Nuclear Energy Academy. He was the Chairman of the Board of Governors of Indian Institutes of Technology (IIT) Bombay and Empowered Committee on IIT Reforms.

Gauhar Raza: *But Germany, now as a unified nation, has taken a decision that it will phase off all reactors by 2022?*

Anil Kakodkar: Yes, it's a national decision but while Germany has taken that decision, Japan has not, even after Fukushima. Japan in fact has taken a decision that nuclear will remain a part of its energy mix. Now, let us look at it in the Indian context. We have significant resources of coal that could be lost may be 50 to 100 years from now. We have plenty of thorium that represents an enormous energy resource but only limited quantity of Uranium that would be necessary to make use of thorium resources at high level of energy use.

I will once again refer to Bhabha's vision about long-term energy security. He had recognized that to improve the standard of living of Indians, we need to enhance energy supply as these two are closely co-related. In industrially advanced countries, the average annual electricity consumption is around 9000 to 10000 units per capita. To reach comparable standards, we need to produce ten folds more electricity. Our coal reserves which would last about 100 years at the current rate of consumption will be exhausted in 10 years if we were to increase consumption ten folds.

That's where the importance of thorium, which is a much more abundant energy resource, comes in. In fact, if you ask a question at that level of consumption, what are the energy sources which will be big enough; there are only two. These are thorium and solar energy.

Gauhar Raza: *What about hydroelectricity power generation?*

Anil Kakodkar: Well, we have not tapped hydel fully as of now and of course we must make full use of available energy sources. However, in the context of the larger needs of the future, the total hydel potential may not exceed eight or ten per cent maximum. So, I think we need to realise that for India's development, our future energy needs are going to be extremely large and we must meet these requirements from energy resources available on the Indian land mass and that means high emphasis on nuclear and solar energy. We should recognize that already oil imports are the largest contributors to our import bill.

Gauhar Raza: *But there is one more criticism of nuclear energy and that is about its safety. How do you react to that?*

Anil Kakodkar: Well, it's not really so. The question is about fatality per unit of electricity produced and when we compare different means of electricity production, you will get the answer that nuclear is the safest. This can be verified through databases anywhere.

Gauhar Raza: *But people are saying that these are sitting bombs.*

Anil Kakodkar: That is the problem of misconceptions. There is no way a nuclear reactor can explode like a nuclear bomb. There are two connotations that we need to differentiate; one is the risk and the other is the so-called disaster syndrome. We need to also make sure that nuclear energy is not associated with any disaster syndrome because that brings in memories of Hiroshima and Nagasaki that actually happened in totally different contexts.

We need to transform nuclear energy to a level where it is immune to any disaster syndrome. In fact at BARC, we did considerable work on this and even now the work is going on. We had evolved the advanced heavy water reactor design that will not have any impact in public domain and would be an operator-friendly system. Similar things are happening the world over.



"We need to realise that for India's development, our future energy needs are going to be extremely large and we must meet these requirements from energy resources available on the Indian land mass and that means high emphasis on nuclear and solar energy."

"Scientists like James Lovelock or people who have originated 'The Greens Movement' have come around to the view that we must tap in to fission energy at least till such time fusion energy comes on the scene least climate change issues become unmanageable and pose threat to our very existence."

So, nuclear technology is learning from the experiences it is accumulating. Let me at this stage also comment on the question about fusion energy you asked earlier. Certainly fusion is literally inexhaustible source of energy and in fact in India we have this programme at the Institute for Plasma Research (IPR), where research on fusion is in progress. India is a participant in the international thermo nuclear experiment reactor project. We will be making several thousand crores worth equipment for that facility in India. The earliest one can expect fusion energy in terms of realistic electricity production would be (may be) another 40-50 years from now. The question is how we survive up to that period.

Scientists like James Lovelock or people who have originated 'The Greens Movement' have come around to the view that we must tap in to fission energy at least till such time fusion energy comes on the scene least climate change issues become unmanageable and pose threat to our very existence. These are important issues that people have to know and understand. In technology terms, we must carry out more research to address challenges before us and realise human development in a very safe manner. **Gauhar Raza:** *You have been a great proponent of solar energy, now is this the confluence of Gandhian thought and the technologist in you?*

Anil Kakodkar: I have had the opportunity of interacting with several people from the Gandhian school of thought. Of course, there are people who have critical views on atomic energy

but there have also been many people who have in fact been great supporters and for that matter motivators for me right from the beginning. The key point is to recognize that technology is a tool. It is the human mind that determines technology being put to good use or bad use.

Gauhar Raza: *Dr. Kakodkar, what has been your personal contribution to this great national project of creating atomic energy in the country?*

Anil Kakodkar: Well, look at the indigenous development of pressurised heavy water reactor technology which is the mainstay of our nuclear program as of now. I had the fortune of carrying out the research and development for technologies of that reactor system. A large number of systems were developed.

The Dhruva research reactor was conceptualized, developed and built by me. I would like to mention also about the advanced heavy water reactor that has been conceptualised. The design is now ready and hopefully the construction of that reactor would start soon.

Then as I grew senior, I had to activate the program in all its dimensions. This created the push for the fast breeder reactor. This also brought in the boost to our work on fusion energy through participation on ITER Project.

Then there was a question of boosting up various inputs that you require for the nuclear energy program, including Uranium and the like. When I figured out that our needs are large

and we need to overcome Uranium constraint, I felt I must do something about getting over this embargo problem. So I worked on that area. Luckily, we have this international civil nuclear co-operation in place (that embargo has now gone).

Then I realised that it's important to be able to develop new technology directly from newly acquired knowledge. So I thought we need to create a different breed of people. That required a different approach to human resource development. This led to the formation of the Homi Bhabha National Institute, which focuses on the research at the interface of basic science and technology.

Gauhar Raza: *Would you like to give a message to the nation, and its younger generation?*

Anil Kakodkar: Well, of course I'm old enough now, but don't think I'm too old. I would say challenges before our country are continuously becoming bigger, at the same time there are huge opportunities for our younger people in the area of science. We need to focus on applying science for national development, and I think time has come for us to think independently, we should be able to derive solutions independently and make the difference for our country.

(The interview is based on a telecast of the interview on Rajya Sabha TV as part of a series called "Eureka")

(Mr Gauhar Raza is Chief Scientist, CSIR-National Institute of Science Communication and Information Resources)

READERSHIP SURVEY

Our readers have great powers. Your opinion carries weight for us. It will go a long way in helping us improve and serve you better with much more interesting, topical and interesting content. So, take some time off and fill up the questionnaire below. We would also like to prepare a readership profile of our magazine. So, please let us know some of your personal details by filling the form overleaf.

1. Rate the overall contents of *Science Reporter* on a scale of 1-5

- ☐ 1 = Dissatisfied
- ☐ 2 = Satisfied
- ☐ 3 = Generally satisfied
- ☐ 4 = Very satisfied
- ☐ 5 = Excellent magazine

2. What percentage of the magazine do you find informative & interesting?

- ☐ 0-10%
- ☐ More than 25%
- ☐ More than 50%
- ☐ More than 75%

3. Rate your interest in each of the specific contents on a scale of 1-7 (1 = Not interested; 7 = Very interested)

- ☐ Cover Story
- ☐ Articles
- ☐ Spectrum
- ☐ Editorial
- ☐ Interview
- ☐ Puzzle Corner
- ☐ Test Your Knowledge
- ☐ Fun Quiz
- ☐ Crossword
- ☐ What's New
- ☐ SciPics

4. How do you rate the following on a scale of 1-7 (1 = Not appealing; 7 = Very appealing)?

- ☐ Cover
- ☐ Layout
- ☐ Font & Font size

5. How long have you been reading *Science Reporter*?

- ☐ For the first time
- ☐ 1-6 months
- ☐ 6-12 months
- ☐ More than 1 year
- ☐ Now and then

6. How long have you been a subscriber?

- ☐ Just started
- ☐ 6 Months
- ☐ 1 Year
- ☐ 2 Years
- ☐ 3 Years

7. From where do you get your copy of *Science Reporter*?

- ☐ Newspaper vendor
- ☐ Annual subscription
- ☐ Through a bookstall
- ☐ Library

8. How long do you keep your copy of *Science Reporter*?

- ☐ One month or less
- ☐ A couple of months
- ☐ Until the next issue arrives
- ☐ Indefinitely, as a reference

9. Which other science magazines do you read?

- 1. _____
- 2. _____
- 3. _____
- 4. _____

10. What suggestion/comment would you like to give to improve *Science Reporter* or what specific topic/subject would you be interested to read in the magazine?

.....

.....

.....

Prize
Puzzle

UNSCRAMBLE



LAYOL

FRENMET

MIANMOA

MOTA

PLCAILYRA

DRYHOBATERAC

RACNOB

BRACON XIODEID

MECHILAC TIONCAER

SLOVESID

NUCTOCD

There are three prizes of Rs 500/- each for three correct entries. In case of a large number of correct entries, the prize winners will be selected through a draw of lots. The decision of the Editor, *Science Reporter* will be final.

Send your entries to:

Puzzle Corner

Editor, *Science Reporter***National Institute of Science Communication & Information Resources (NISCAIR)**

Council of Scientific and Industrial Research (CSIR)

Dr KS Krishnan Marg, Pusa Campus

New Delhi-110012

Last date for the
entries to reach us:
05-09-2016

Name :

Address :

Pin code:

Age : Email: Sex:

Occupation : ☐ Student ☐ Housewife ☐ Teacher ☐ Professional ☐ Retired ☐ OtherEducational level : ☐ Primary ☐ Secondary ☐ Graduate ☐ Postgraduate

- Please fill up the questionnaire at the back
- You can send your answers on a photocopy of this page as well.

ELEMENTS PUZZLE

1. A chemical element of 13th group and 2nd Period

2. Alkaline earth metal with atomic number 12

3. Noble gas belongs to 4th period

4. 3rd most abundant element in the universe

5. Elements having highest electronegativity

6. Transition metal with Atomic Number 28

7. Deficiency of this elements leads to Hypothyroidism

8. Actinide element having radioactivity, with atomic number 92

9. Element having maximum oxidation state of +8

Contributed by Sindhe Veera Sivaji, Chemist-QA, Alkaloids Pvt. Ltd. (U-II), LIG-71, 2-126, Housing Board Colony, Medchal, Ranga Reddy, Telangana-501401; Email: sivajibio@gmail.com

MATCH THE ORGAN

- | | | | | |
|------------------|----------------------|-------------------|-----------------------|------------------------|
| 1. EUGLENA | a. Pseudopodium | b. Chloroplast | c. Volutin | d. Cilia |
| 2. PARAMECIUM | a. Cytostome | b. One Nucleus | c. One vacuole | d. Flagellum |
| 3. PHYSALIA | a. Spicules | b. Porocyte | c. Osculum | d. Nematocyst |
| 4. PLEUROBRACHIA | a. Nematocyst | b. Polyp | c. Comb plates | d. Ostia |
| 5. MEGASCOLEX | a. Parapodium | b. Pseudopodium | c. Chlorocogen cells | d. Ventral heart |
| 6. NEREIS | a. Penial setae | b. Aciculum | c. Eyes | d. Fins |
| 7. HIRUDINEA | a. Botryoidal tissue | b. Caecae | c. Jaws | d. All the above |
| 8. PENAEUS | a. Paired Wings | b. Paired legs | c. Petasma | d. Pedipalp |
| 9. THRIPS | a. Lace wings | b. Fringed wings | c. Tegmina | d. Membrane wings |
| 10. GRASSHOPPER | a. Long Antenna | b. Long Fore legs | c. Stridulatory organ | d. Sucking mouth parts |
| 11. SCORPION | a. Gills | b. Lungs | c. Book lung | d. Gill book |
| 12. PILA | a. Bivalve | b. Ommatidium | c. Osphradium | d. Ink sac |
| 13. SEPIA | a. Umbo | b. Byssus thread | c. Ink sac | d. Coiled shell |
| 14. AMPHIOXUS | a. Jaws | b. Fins | c. Lung | d. Nephridia |
| 15. SCOLIODON | a. Ctenoid scale | b. Placoid scale | c. Homocercal fin | d. Cycloid scale |

Contributed by Dr. K. Venkataraman, Retd. Reader and Head, Dept. of Zoology, Madura College.
Address: A-T-2 Porkudam Apartments, Bypass Road, Madurai-625 016 Email: durai1491@hotmail.com

Solutions to the puzzles published in the June 2016 issue

Prize Puzzle: Glass Puzzle

Pour water from the second glass filled with water into the second glass that is empty and you have alternate full and empty glasses.

LOLLYPOP PUZZLE

CORNEA

NIBBLE

PHOT

The word formed from the letters left out is "MASS"

The names of the prizewinners of the Prize Puzzle based on a draw of lots from among the correct entries are as follows:

- Nihal Sachan, S2 Gurushakti Apartment, 673 W1 Saket Nagar, Kanpur-208014
- T.M. Mathew, Thundiyl, Jehovah Nissi-Manakkachira, Nettoor PO, Kochi-682040
- Chaitanya Ghadekar, 11 Damodar Society, Civil Lines, Nagpur, Maharashtra-440001

Congratulations all the winners!

2D



GRAPHENE

Wonder Material

The next time you hold a pencil in your hand, remember that the world's most powerful substance is at your fingertips.

What is Graphene?

- Graphene is an allotrope of carbon, synthesised from Graphite. It is the thinnest, strongest, & most conductive material known today.
- Observed first in 1960
- Re-discovered, isolated & characterized by Andre Geim & Konstantin Novoselov of Russia in 2004



Received Nobel Prize in Physics 2010



Graphene's structure

- 1 atom thick sheet of carbon atoms arranged in a honeycomb pattern
- Molecule bond length is 0.142 nanometers

Graphene's Unique Properties

- Thinnest known material
- Impermeability
- Highly conductive
- Lightest material
- Highly transparent
- Flexible
- Hardest material

Applications of Graphene

Computing - To improve processing power of Computer Chips

Energy storage - Used in photovoltaic cells, quick charging batteries

Medicine - It can be utilized in bioelectric sensors, bio-imaging devices, drug & gene delivery, artificial implants.

Water purification - Efficient water filter, can be used in desalination plants

Water proofing materials - For smartphones, buildings and electronics

Electronics - Replace Silica in electronics circuits.

Future Applications of Graphene

- Superfast broadband internet which can download blu-ray movies in seconds.
- Solar batteries that take only minutes to charge, long lasting & are lighter.
- Waterproof coating can be prepared by mixing graphene with paint.
- Enable a new generation of flexible & lighter smartphone & laptops.
- Adding graphene to plastics can turn them stronger & conductive.
- Lighter & more energy efficient automobiles, aircrafts & trains.
- Technology to convert sea water into drinking water.

200 times stronger than steel

Million times thinner than human hair

200 times more conductive than silicon

Absorbs only 2.3% of light

Nearly 25855 patents already filed around the world till 2014



Sources :

1. www.graphene.manchester.ac.uk
2. www.extremetech.com
3. <https://gigaom.com>
4. www.explainthatstuff.com
5. www.visualcapitalist.com

6. <http://cleantechnica.com>
7. www.graphenea.com
8. <https://gigaom.com>
9. www.understandingnano.com
10. <http://www.nanowerk.com/>

Compiled by: Viswanath G.S, Technical Assistant,
National Science Library, CSIR-NISCAIR,
New Delhi, Email: viswanath@niscair.res.in

THE TARABRELLA



TARAbrella is the world's first super umbrella that has its own built-in weather forecast system. Apart from integrated advanced weather detection system, this smart umbrella features glowing LED tip, anti-lost tracker and carbon fiber material which is five times stronger than steel. It uses a built-in digital barometer to monitor the atmospheric air pressure, once every 35 seconds. It also tracks humidity using an onboard hygrometer. Users are alerted to potential rain via a colour-changing LED display in the handle of the umbrella. Transparent for sunny or partially cloudy days, flashing blue means cloudy skies with a chance of drizzle and solid blue warns of rain. (www.indiegogo.com)

THE EXO360 DRONE



The **Exo360** is a drone with five cameras enabling footage in 360 degrees, which can later be viewed on a virtual reality headset including Oculus Rift and Samsung Gear. The camera shoots 4k videos at 30 frames per second and HD1080p/30 and spherical images at 60 megapixels. Four of the cameras are located at the end of the drone's four arms and one is located under the main body. The drone has a flight time of 18 minutes with a 3 km range and can handle itself in winds of up to 15 miles per hour. The drone weighs 1.8 kg and comes with 256 GB on board storage. (www.queenb-robotics.com)

POPPITS SOFTGEL PODS

With the new poppits soluble toothpaste pods, squeezing paste from the bottom of the tube could be a thing of the past. The water-soluble softgel pods are made of edible plant-derived cellulose. Each pod is filled with the dentist-recommended amount of toothpaste required for brushing, and the paperboard in which they are packaged biodegrades in few weeks. There are 90 poppit pods in a packet. The toothpaste inside the pods is fluoride free and made from natural ingredients. There are mint-flavored Whitening Poppits for adults and three fruity flavors (Sweet Strawberry, Green Apple and Merry Berry) for kids. (www.digitaltrends.com)

BE6i IN-EAR HEADPHONES



The **BE6i** wireless Bluetooth headphones are fabricated from light weight aluminium with IPX5 protection rating. The headphones are compatible with AAC and aptX streaming with a wireless range of up to 100 feet. It gives the frequency response as 20Hz to 20 kHz with 95 dB sensitivity and an input impedance of 20 ohm. The headphones come with silicon ear wings for more secure fit. Newly developed 10 mm driver eliminates unwanted reverberations by using a high-grade titanium, magnesium and inert metal for distortion-free sound even at high volume levels. The Bluetooth earphones are available in gray or gold colour with battery life up to 8 hours on a single charge. (www.optomaeurope.com)

A bizarre creature discovered
deep in a Croatian cave



Blind Fly: New Flying Insect found in a Croatian Cave

Image Credit: Journals.plos.org

A bizarre flying insect has been discovered in one of the deepest caves (Lukina Jama-Trojama Cave) of Southern Croatia at a depth of about 900-1000 meters. This cave has received attention by cave scientists for its rich fauna. In a recent article published in the journal *PLOS ONE*, a team of scientists found a new species of non-biting midge.

The Lukina jama-Trojama cave is 1,431 m deep making it the 14th deepest cave in the world.

The scientific name given to the *Troglocladius hajdi* refers to both its subterranean feature and the local folklore. Terrestrial species found in caves are generally characterized as troglaphiles and troglobionts. The new species are troglobionts, cave-dwellers, which spend their entire life in the caves whereas troglaphiles (like bat) can survive outside. Troglobionts are found in extreme environments, where mating might be difficult. This discovery would contradict the previous beliefs that only bats are capable of flying in darkness, making *T. hajdi* the first flying troglobiont.

The team of scientists couldn't find the males and observed only the females. Furthermore, the larvae and pupae of *T. hajdi* are still unknown. It has a pale-yellow body, short antenna, wings that are long and broad, and long forelegs, which may act as 'feelers' during the flight. These unique features depict its ability to fly in the complete darkness of the cave.

Besides flying, what the tiny insect does in the cave is still unclear.

Source: journals.plos.org



Newly emerged specimen of
Troglocladius hajdi

Image credit: J. Bedek

INTERNET PIONEERS

BIBHUPRASAD MOHAPATRA

1. An American electrical engineer who along with Vint Cerf invented the Transmission Control Protocol (TCP) and the Internet Protocol (IP), the fundamental communication protocols at the heart of the internet.

- a) Lawrence G. Roberts b) Robert E. Kahn
c) Raymond Samuel Tomlinson d) Leonard Kleinrock

2. An American internet pioneer, who is recognized as one of "the fathers of the internet", sharing this title with American engineer Bob Kahn.

- a) Louis Pouzin b) Vinton Gray Cerf
c) Jonathan Bruce Postel d) Paul Baran

3. An English computer scientist, best known as the inventor of the World Wide Web (WWW).

- a) Tim Berners-Lee b) Marc Lowell Andreessen
c) Tom Truscott d) Stephen D. Crocker

4. Finland born internet pioneer, who is the inventor of the first Internet chat network, called Internet Relay Chat.

- a) Robert Cailliau b) Gary Thuerk
c) Jarkko Oikarinen d) Tom Truscott

5. An American engineer and inventor, and an early computer and Internet pioneer, who invented the computer mouse.

- a) David Bohnett b) Johns Frederick Rulifson
c) Valerie Landau d) Douglas Engelbart

6. An Indian American entrepreneur who founded the Hotmail email service and Jaxtr.

- a) Sabeer Bhatia b) Vinod Dham
c) Vinod Khosla d) Rajeev Motwani

7. An American computer scientist and entrepreneur, best known for creating the Morris Worm in 1988, considered the first computer worm on the Internet.

- a) Eddie Kohler b) John McCarthy
c) Robert Tappan Morris d) Tom Truscott

8. Taiwanese-born American Internet entrepreneur, best known as the co-founder and previous Chief Technology Officer (CTO) of the popular website YouTube.

- a) Chad Meredith Hurley b) Steven Chen
c) Ivan Edward Sutherland d) Jonathan Bruce Postel

9. A Taiwanese American Internet entrepreneur, engineer, the co-founder and former CEO of Yahoo! Inc.

- a) Jerry Yang b) Terry Semel
c) David Filo d) Marissa Ann Mayer

10. Indian origin inventor and entrepreneur, who developed an electronic version of an interoffice mail system in 1979, which he called "EMAIL" and copyrighted in 1982.

- a) Anil Kamath b) Raymond Samuel
c) V A Shiva Ayyadurai d) J C R Licklider

11. An American pioneer of IT, philosopher and sociologist, who coined the term "hypertext" and "hypermedia" in 1963, and published them in 1965.

- a) Vannevar Bush b) Theodor Holm Nelson
c) Andries van Dam d) Paul Marie Ghislain Outlet

12. In 1971, he created the standard Internet electronic mail addressing format, using the @ sign to separate mailbox names from host names.

- a) Ray Tomlinson b) Michael Stern Hart
c) Steven J. Sasson d) Andries van Dam

13. 1971 born American entrepreneur, investor, and software engineer, best known as co-author of Mosaic, the first widely used Web browser.

- a) David Carl Drummond b) Marc Lowell Andreessen
c) Eric Emerson Schmidt d) Michael Stern Hart

14. An American computer scientist and Internet entrepreneur who co-founded Google with Sergey Brin, one of the world's most profitable Internet companies.

- a) Lawrence Page b) Marc Lowell Andreessen
c) Vannevar Bush d) Raymond Samuel

15. A German-American Internet entrepreneur, best known for being a co-founder of YouTube and the first person to upload a video on it.

- a) Susan Diane Wojcicki b) Jawed Karim
c) Anne E. Wojcicki d) Salar Kamangar

16. An American computer programmer and entrepreneur, who is the creator and lead developer of Gmail. He had already explored the idea of web-based email in the 1990s, before the launch of Hotmail, while working on a personal email software project as a college student.

- a) Bret Taylor b) Jim Norris
c) Paul T. Buchheit d) Craig Alexander Newmark

17. An American mathematician, electronic engineer, and cryptographer known as "the father of modern information theory" and published a landmark paper "A Mathematical Theory of Communication" in 1948.

- a) Claude Shannon b) George Boole
c) Norbert Wiener d) Ralph Vinton Lyon Hartley

18. A Polish-born American engineer who was a pioneer in the development of computer networks. In 2012, he was inducted into the Internet Hall of Fame by the Internet Society.

- a) Donald Watts Davies b) Paul Baran
c) Lawrence G. Roberts d) Leonard Kleinrock

ANSWERS:

- 1) b 2) b 3) a 4) c 5) d 6) a 7) c 8) b 9) a
10) c 11) b 12) a 13) b 14) a 15) b 16) c 17) a 18) b

Contributed by Mr. Bibhuprasad Mohapatra, CBSCPC, Satyanaga Bhubaneswar-751007, Odisha; Email: padmacharan123@gmail.com

Nuclear Power

DILEEP BHATIA

- Name the isotope of uranium which takes part in nuclear fission.
 - Uranium-238
 - Uranium-233
 - Uranium-235
 - All of the above
- How many nuclear reactors are in operational stage in India?
 - 20
 - 19
 - 22
 - 21
- Name the place where maximum numbers of nuclear power units are in operation in India.
 - Tarapur
 - Kaiga
 - Kudankulam
 - Rawatbhata
- Name the place which is producing maximum nuclear power in India.
 - Tarapur
 - Kudankulam
 - Rawatbhata
 - Kaiga
- What is the chemical name of heavy water?
 - Hydrogen oxide
 - Deuterium dioxide
 - Deuterium oxide
 - Heavy hydrogen oxide
- Name the place where nuclear power plant will be constructed in Haryana state.
 - Gorakhpur
 - Hissar
 - Gurgaon
 - Bhivani
- The mass number of an element is not changed when it emits _____ radiations:
 - Alpha & Beta
 - Alpha & Gamma
 - Beta & Gamma
 - Alpha, Beta & Gamma
- The second underground nuclear test was conducted by India at _____.
 - Pokhran
 - Narora
 - Jaisalmer
 - None of the above
- ALARA principle is used for radiation protection in nuclear power plants. What does ALARA stand for?
 - As Low As Rationally Achievable
 - As Low As Reasonably Achievable
 - As Low As Regulatory Achievable
 - As Low As Rotationally Achievable
- One amu is equivalent to:
 - 931 Mev
 - 931 ev
 - 9.31 Mev
 - 931 J
- Which nuclear power unit operated continuously for 765 days in India and made a record?
 - Rajasthan Rawatbhata Unit 5
Kudankulam Unit 1
 - Tarapur Unit 4
 - Madras Unit 1
- At which duration off-site radiological emergency exercise is conducted at nuclear power site?
 - Once in 6 months
 - Every year
 - Once in 5 years
 - Once in 2 years
- What is unit of radiation dose measurement?
 - Joule
 - Rotengen
 - Sievert
 - Curie
- What is allowable radiation dose to public from nuclear power site in one year?
 - 5 mSv
 - 100 mSv
 - 1 Sv
 - 1 mSv
- Who monitors radiological conditions in the environment at nuclear power sites?
 - Nuclear Power Corporation of India Limited
 - Environmental Survey Laboratory of Bhabha Atomic Research Center
 - State Metrological Laboratory
 - Health Physics Unit of power plant
- Name the body that regulates activities of Indian nuclear power plants.
 - Atomic Energy Commission
 - Department of Atomic Energy
 - Nuclear Power Corporation of India Limited
 - Atomic Energy Regulatory Board
- In which state Kudankulam power plant is situated?
 - Kerala
 - Tamil Nadu
 - Karnataka
 - Orissa
- Which of the following may not need a moderator?
 - CANDU reactor
 - Fast breeder reactor
 - Homogeneous reactor
 - Pressurized water reactor
- Which of the following is used to measure the rate of nuclear disintegration?
 - Cold chamber
 - Geiger-Muller counter
 - Cyclotron
 - Mass spectrograph
- Which is the most commonly used molten metal for cooling of nuclear reactors?
 - Sodium
 - Calcium
 - Mercury
 - Zinc

ANSWERS:

- 1) c 2) d 3) d 4) a 5) c 6) a 7) c 8) a
 9) b 10) a 11) a 12) d 13) c 14) d 15) b 16) d
 17) b 18) b 19) b 20) a

Contributed by Mr. Dileep Bhatia, Rawatbhata-323307, Kota, Rajasthan;
 Email: dileepkailash@gmail.com



Nature, the Healer

MAYANGLAMBAM OJIT KUMAR SINGH

1. 90% of children diagnosed with leukemia survive these days. This is thanks mainly due to anticancer chemical compounds called vincristine from a popular garden plant. Name this shrubby plant useful for treatment of Leukemia, Hodgkin's lymphomas, Kaposi's sarcoma and cancers of brain, bladder, testes, breast and lungs.

- (a) Rosy periwinkle (b) Aloe Vera
(c) Daffodil (d) Forget me not



2. Known for the treatment of sunburn, minor burns, cuts, skin irritations. This popular house plant grown on the window sills around the world has an ancient pedigree as skin balm dating back more than 6000 years.

- (a) Opuntia (b) Aloe Vera
(c) Petunia (d) Neem



3. The heart drug digoxin for the treatment of congestive heart failure is extracted from this plant. Recent report states that men who take digoxin for 10 years or longer are at 46% lower risk of prostate cancer.

- (a) Lavender (b) Kudzu
(c) Foxglove (d) Tea tree



4. The bulb of this plant contains high levels of galantamine which helps brain cells communicate with each other. Also known as Jonquille or Lent lily, this plant is a promising new source of drug for the treatment of Alzheimer's.

- (a) Flax
(b) Khella
(c) Ephedra
(d) Daffodil



5. The root of this plant has been the ancient Eastern health elixir having a great reputation for boosting vitality and memory. Name this plant which is considered to be the best-selling twenty-first century botanical.

- (a) Evening primrose (b) Eyebright
(c) Hoodia (d) Ginseng



6. Which other name is given to *Rauwolfia serpentina* also known as sarpagandha, a herb that has been used in Indian Ayurvedic medicine for centuries to treat snakebites, insect stings, insomnia? The world's first breakthrough high-blood pressure medication called serpina in the 1930s was originally derived from this plant.

- (a) Butterbur (b) Curare
(c) Snakeroot (d) Castor Bean



7. The compound called podophyllotoxin is used to make etoposide, a drug that is used alone to treat cancer. What other common name is given to this rare herb?

- (a) Chinese happy tree
(b) Mayapple
(c) Feverfew
(d) Red clover



FUNQUIZ

8. This primitive vertebrate is becoming a promising source of new medicines to treat a huge range of serious infections while avoiding the problems of antibiotic resistance. An extract of the serum (white blood cells) of this animal kills a staggering 23 different strains of bacteria including the yeast *Candida albicans*, one of the main micro-organisms responsible for infections in diabetics, HIV patients and organ transplant recipients.

- (a) American Alligator
- (b) Gharial
- (c) Komodo lizards
- (d) Southern copperhead



9. This animal is better understood for spreading diseases rather than curing them. However a recent finding is that of antibacterial compounds in its brain which is said to be effective against many notoriously difficult to combat deadly strains of bacteria.

- (a) Cockroaches
- (b) Woodlice
- (c) Booklice
- (d) Thrips



10. This colorless animal belongs to jellyfish species which surprisingly produces a faint ring of glowing green specks around its outer edge. This animal has provided researchers with one of the most revolutionary laboratory tools of the twenty first century called green fluorescent protein (GFP).

- (a) Crystal Jelly
- (b) Water Jelly
- (c) Comb Jelly
- (d) Sea Jelly



11. This nocturnal predator snail is slow moving. This animal is responsible for the development of the world's most powerful painkillers. It is also called the cigarette snail.

- (a) Dall's Cone
- (b) Magician Cone
- (c) Geography Cone
- (d) Textile cone



12. This animal hunts at night and by day it roosts in dark places such as caves and disused buildings. A compound in its saliva keeps blood flowing. It has been harnessed to develop a new anticoagulant drug for dissolving dangerous blood clots.

- (a) Dracula
- (b) Fruit Bat
- (c) Flying fox
- (d) Vampire Bat



Answers:

1) a: American and Canadian doctors took notice of this plant during World War II, when soldiers stationed in the Philippines used periwinkle to treat diabetes during insulin shortages.

2) b: The gel inside the Aloe Vera leaves speeds healing of the damaged skin possibly by improving circulation and encouraging new skin cells to move up into the areas that need repairs.

3) c: Dr. William Withering, after treating more than hundred patients (156 exactly), he concluded that small amounts of the dried leaf of foxglove eased dropsy without causing toxic side effects.

4) d: Galantamine is known to improve memory and thinking skills in people with mild to moderate dementia.

5) d: Ginseng is one of the world's most sought-after herbs according to the World Health Organisation.

6) c: Thanks to its calming effect the herb is also used in mental disorders. In 1940, a pioneering Indian cardiologist named Rustom Jal Vakil published the first research documenting snakeroot's effects in people.

7) b: The rhizome of the plant contains a resin, which can be processed to extract podophyllotoxin, or podophyllin, a neurotoxin.

8) a: American Alligator can survive massive injuries that would kill many other species. Researchers are of the opinion that a particular peptide or fragments of proteins must be lurking in the WBCs of alligator blood.

9) a: It is possible and makes good sense that chemical defences would allow such animals such as cockroaches which live in dirty places without becoming infected themselves.

10) b: Water jelly has been used to show how cancer cells spread and how neurons in the brain develop and to investigate the behavior of the AIDS virus.

11) c: *Conus geographus* also called geography cone because of detailed map-like patterns on its shell. Also called cigarette snail because when a person is stung by one, he is said to have just enough time to smoke a cigarette before dying from its venom.

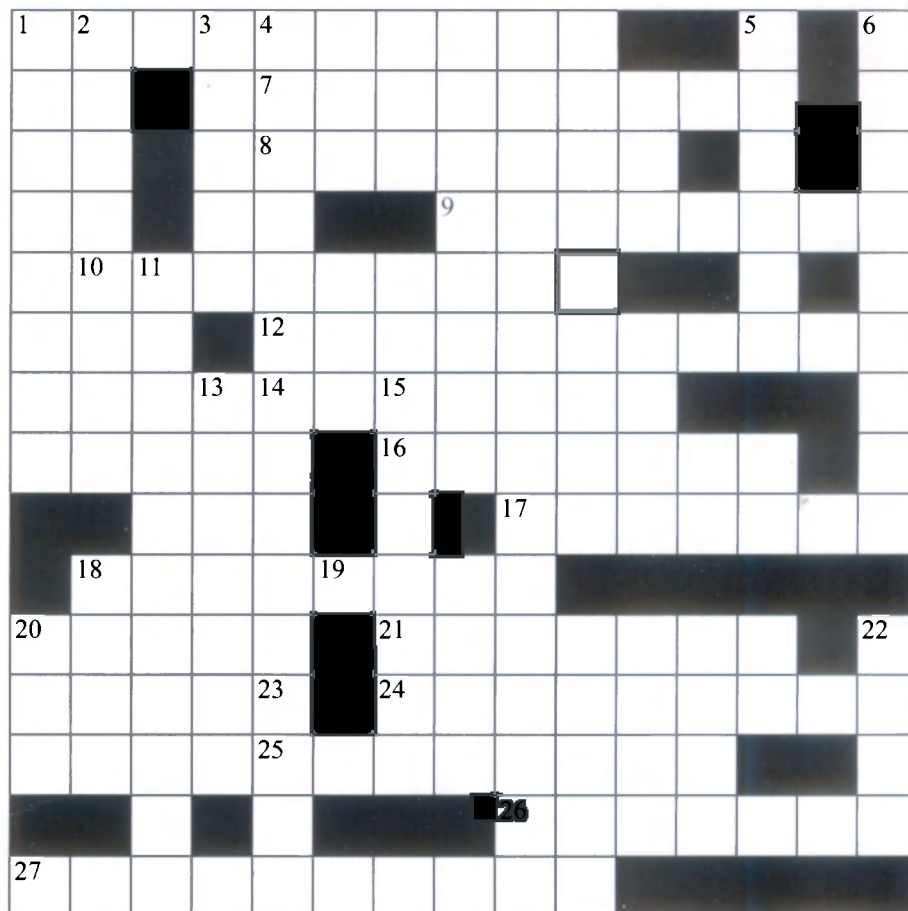
12) d: The common vampire bat is found in the tropics of Mexico, Central America, and South America.

Contributed by Mayanglambam Ojit Kumar Singh, Assistant Professor in Zoology and Life Sciences, Ramjas College, Delhi University, Maurice Nagar, Delhi 110007; Email: ojit102005@yahoo.co.in

CROSSWORD

ACROSS

1. Chemical name of Vitamin E (10)
7. Menstrual hormone (8)
8. Sugar found in nucleic acids (7)
9. Compound with Cyclopentano-perhydro-phenanthrene skeleton (7)
10. A product of cleavage of Arginine in Urea cycle (9)
12. Phosphoric acid + Pentose sugar + Nitrogenous base (10)
14. Hormone that converts Glucose to Glycogen (7)
16. A pyrimidine base of DNA (7)
17. Protein found in hair (7)
19. Chemical found in human urine, also used as fertilizer (4)
21. Constituent of lecithin and sphingomyelin (7)
24. Product of decarboxylation of Histidine, also responsible for allergic reaction (9)
25. Neurotransmitter of Catecholamine group (8)
26. Protein found in egg white (7)
27. Emergency hormone (10)

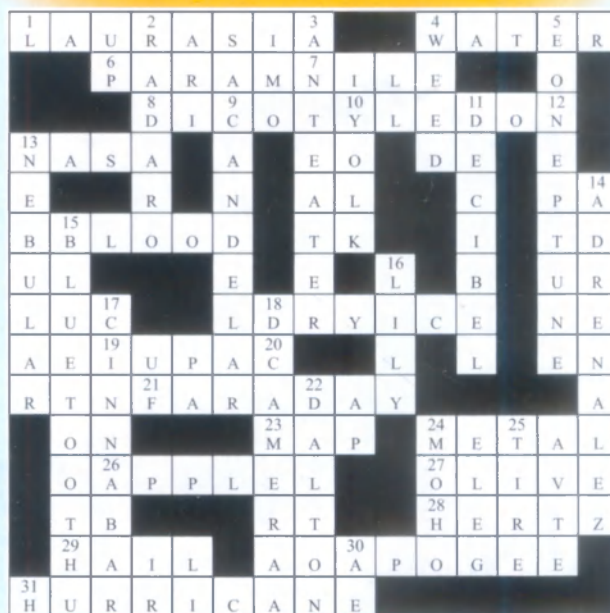


DOWN

1. Thromboplastin converts Prothrombin into (8)
2. Hormone that causes contraction of uterine wall and ejection of milk (2)
3. Protein part of Rhodopsin (5)
4. Proteolytic enzyme found in gastric juice (6)
5. Protein found in the thin filament of sarcomere (5)
6. Constituent of fat (8)
11. Deficiency of this vitamin leads to cheilosis (10)
12. Pellagra preventive factor (6)
13. Anticoagulant found on the walls of blood vessels (7)
15. Polysaccharide found in root vegetables (6)
18. Yellow coloured fluid secreted by liver (4)
20. Secreted by honey bee to form honey comb (3)
22. Prosthetic group of hemoglobin (4)
23. Abbreviation of Lactic dehydrogenase (3)

Contributed by Dr. K. Venkataraman, A-T-2, Porkudam Apartments, Bypass Road, Madurai-16

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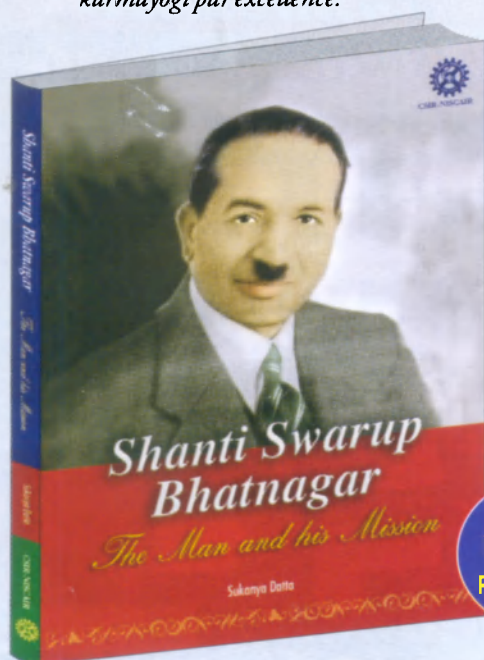
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